PB-216 706

EXAMINATION INTO THE EFFECTIVENESS OF THE CONSTRUCTION GRANT PROGRAM FOR ABATING, CONTROLLING, AND PREVENTING WATER POLLUTION

Comptroller General of the United States
Washington, D. C.

3 November 1969

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REPORT TO THE CONGRESS

Examination Into The Effectiveness Of The Construction Grant Program For Abating, Controlling, And Preventing Water Pollution B-166506

Federal Water Pollution Control
Administration
Department of the Interior

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UNITED STATES GENERAL ACCOUNTING OFFICE

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-166506

To the President of the Senate and the
Speaker of the House of Representatives

This report presents the results of our examination into the effectiveness of the construction grant program of the Federal Water Pollution Control Administration, Department of the Interior, for abating, controlling, and preventing water pollution.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Bureau of the Budget, and to the Secretary of the Interior.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

EXAMINATION INTO THE EFFECTIVENESS OF THE CONSTRUCTION GRANT PROGRAM FOR ABATING, CONTROLLING, AND PREVENTING WATER POLLUTION B-166506

DIGEST

WHY THE REVIEW WAS MADE

Because of the substantial expenditure of Federal funds and expressed interest of several congressional committees in the water pollution control program, the General Accounting Office (GAO) has examined into the effectiveness of the Federal Water Pollution Control Administration's (FWPCA) construction grant program for abating, controlling, and preventing water pollution.

FINDINGS AND CONCLUSIONS

During fiscal years 1957 through 1969, FWPCA awarded grants to States, municipalities, and intergovernmental agencies of about $1.2 billion for the construction of more than 9,400 projects having a total estimated cost of about $5.4 billion.

These projects have contributed to abating water pollution because the problem would have been worse if the projects had not been constructed. GAO believes, however, that the benefits have not been as great as they could have been because many waste treatment facilities have been constructed on waterways where major polluters--industrial or municipal--located nearby continued to discharge untreated or inadequately treated wastes into the waterways. (See ch. 4 for eight examples that demonstrate this point.)

The names of the rivers and municipalities have not been identified in the examples because the purpose of the examples is to demonstrate the existence of a problem which GAO believes to be widespread and not to highlight the actions or inactions by specific polluters on the few waterways reviewed.

The program to date has been administered for the most part using a shotgun approach--awarding construction grants on a first-come-first-served or readiness-to-proceed basis. Little consideration has been given to the immediate benefits to be attained by the construction of individual treatment plants.

Tear Sheet

NOV. 3,1969

This approach can no longer be justified. Grants should be awarded on a more systematic basis, giving consideration to the benefits to be attained.

Pursuant to the Water Quality Act of 1965, the States have developed implementation schedules for the construction of waste treatment facilities by municipalities and industries. A serious question exists, however, as to the attainability of the water quality standards by the dates in the implementation schedules because, due to Federal funding in amounts significantly less than amounts authorized, construction is proceeding at a rate well below that which was anticipated. Most of the States are constructing waste treatment facilities at a rate consistent with the availability of Federal funds, therefore the backlog of municipalities awaiting Federal funds is increasing constantly.

GAO believes that the present level of Federal funding will not be sufficient to enable a significant increase in the effectiveness of the program in abating, controlling, and preventing water pollution. In view of the magnitude of the problem and on the basis of the present level of Federal funding, it will be many years before the construction grant program is completed.

GAO believes that the States, in establishing priorities, and FWPCA, in awarding grants, should consider the benefits to be derived from the construction of individual treatment facilities. FWPCA and State agencies should be able to choose from alternatives and establish priorities on the basis of benefits to be obtained. GAO believes that the application of systems analysis techniques to water pollution problems may be appropriate and that the use of systems analysis techniques by FWPCA and the States should lead to improving the effectiveness of the construction grant program.

Problems, which have adversely affected the water pollution control program in the past and probably will continue to affect the program in the future, include

--pollution from overflow of combined storm and sanitary sewers and from infiltration of sewers,

--pollution from factors such as natural pollutants, thermal pollution, and pollutants from runoffs,

--failure of communities to authorize bond issues,

--insufficient numbers of trained personnel,

--insufficient funding at all levels, and

--the fact that water pollution has no political or geographical boundaries, and actions of one municipality or State affect other municipalities and States.

FWPCA and the States must find ways to overcome these problems if the program is to become more effective.

More consideration could be given to planning and implementing water pollution control programs on a river basin basis or to administering the construction grant program through a State agency which would be responsible for the planning, designing, constructing, operating, and maintaining of all waste treatment facilities within the State.

RECOMMENDATIONS OR SUGGESTIONS

GAO is recommending that the Secretary of the Interior require that the States, in establishing priorities for the construction of waste treatment facilities, and FWPCA, in approving grants for such construction, give consideration to (1) the benefits to be derived from the construction of the facilities and (2) the actions taken, or planned to be taken, by other polluters of the waterways.

FWPCA should consider utilizing systems analysis techniques in the planning for and implementing of water pollution control programs. FWPCA should consider also the practicability of providing, through its storage and retrieval of data (STORET) system (see p. 96), data needed by the States in

--determining their water pollution control requirements,

--identifying alternatives available to solve water pollution problems,

--formulating water pollution control plans, and

--establishing implementation schedules and priorities for the construction of waste treatment facilities.

AGENCY ACTIONS AND UNRESOLVED ISSUES

On September 25, 1969, drafts of this report were submitted to the Department of the Interior; the Office of Science and Technology, Executive Office of the President; and the State water pollution control agencies of the eight States included in GAO's review.

The recipients agreed generally with the findings discussed in the report. The Office of Science and Technology stated that the report was excellent and that the conclusions and recommendations were sound. The Department of the Interior agreed with all the recommendations but disagreed with some of the conclusions. Some of the States disagreed with some of the conclusions and recommendations.

The comments of the Federal and State agencies and GAO's evaluations thereof are discussed in chapter 7.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The Federal Water Pollution Control Act provides that priorities for FWPCA construction grants be established on the basis of financial and water pollution control needs. GAO believes that priorities should be established on the basis of benefits to be obtained and that a coordinated effort is required on the part of all polluters of a waterway to attain the maximum benefits from the construction grant program. GAO believes that the requirement that financial need be a factor in establishing priorities could result in FWPCA's awarding grants for the construction of projects which provide little benefit in terms of appreciably improving water quality or uses.

Accordingly, and in view of (1) the magnitude of the program required for the construction of waste treatment facilities and (2) the backlog of grant applications for Federal funds, the Congress may wish to consider amending the act to provide that priorities for grant awards be established on the basis of the benefits to be realized.

Although the Department of the Interior has agreed with GAO's basic premise that a more systematic means of awarding construction grants must be found to secure greater benefits in pollution abatement, and has agreed with the recommendations set forth in this report, it has taken the position that providing for less than secondary treatment of wastes would not be acceptable and that interim goals should not be established. GAO continues to believe that interim goals should be established and that the providing of less than secondary treatment would be desirable under certain circumstances as discussed on page 16 of this report.

Accordingly, GAO is recommending that the Congress consider requiring the Department of the Interior to provide for interim goals and to allow communities to construct less than secondary treatment facilities when it can be demonstrated that a lesser degree of treatment will result in water quality enhancement commensurate with proposed present and future water uses.

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ABBREVIATIONS

APW	Accelerated public works
ARA	Area Redevelopment Administration
BOD	Biochemical oxygen demand
CDM	Camp, Dresser & McKee
FWPCA	Federal Water Pollution Control Administration
GAO	General Accounting Office
HEW	Department of Health, Education, and Welfare
PE	Population equivalents
PPB	Planning, programming, and budgeting
STORET	Storage and retrieval of data
WAS	Waste Acceptance Service

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CHAPTER 1

INTRODUCTION AND SCOPE OF REVIEW

The General Accounting Office has examined into the effectiveness of the construction grant program administered by the Federal Water Pollution Control Administration for abating, controlling, and preventing water pollution in the United States. This program is authorized by the Federal Water Pollution Control Act of 1956, as amended (33 U.S.C. 466).

Our review was directed primarily to an evaluation of FWPCA's policies, procedures, and practices relative to the planning and implementation of its construction grant program. The review covered the period from the passage of the Federal Water Pollution Control Act of 1956 to June 1969.

We obtained, analyzed, and evaluated information relating to State and Federal water pollution control plans, programs, and water quality standards as they affected the approval and award of Federal construction grants to municipalities. We examined into the improvements resulting from the construction of selected waste treatment facilities.

During our review, it became apparent that systems analysis techniques might be used to improve the planning aspects of the construction grant program. Because of the technical nature of data used in such an approach, we contracted with the consulting engineering firm of Camp, Dresser & McKee (CDM) of Boston, Massachusetts, to assist in this phase of the review. CDM used the Merrimack River in New Hampshire and Massachusetts to demonstrate the practicality of the method devised.

Our review was conducted at FWPCA headquarters in Washington, D.C.; at FWPCA regional offices in Boston, Massachusetts; Portland, Oregon; and Dallas, Texas; and at State water pollution control agencies in Augusta, Maine; Boston, Massachusetts; Concord, New Hampshire; Baton Rouge and New Orleans, Louisianna; Austin, Texas; Little Rock, Arkansas; Portland, Oregon; and Olympia, Washington; and visits were made to sections of waterways, to municipalities, and to local planning organizations in these States.

We reviewed the (1) States' water pollution control plans submitted to FWPCA, (2) water pollution control programs as carried out by the States, (3) States' water quality standards (criteria and plans of implementation), (4) enforcement conference reports, (5) program grant expenditures, and (6) FWPCA manuals, correspondence, and reports. We also held discussions with responsible FWPCA headquarters and regional office officials, as well as officials of the various State water pollution control agencies, selected municipalities, and local planning organizations.

The principal officials of the Department of the Interior responsible for the administration of the activities discussed in this report are listed in appendix XII.

LEGISLATION

Although many bills dealing with water pollution were introduced prior to 1948, it was not until that year that specific legislation was enacted for water pollution control. This was Public Law 80-845, a measure providing for an experimental water pollution control program in the Public Health Service of the Federal Security Agency--the predecessor agency to the Department of Health, Education, and Welfare (HEW).

Permanent water pollution control legislation was enacted July 9, 1956, with the passage of the Federal Water Pollution Control Act. The act provided for Federal participation in a wide variety of water pollution control activities, including Federal-State cooperation in developing comprehensive water pollution control programs, increased technical assistance to States, intensified and broadened research programs, grants for the support of State water pollution control programs, and grants for the construction of waste treatment facilities.

The 1956 act was amended by Public Law 87-88 approved on July 20, 1961. This new legislation strengthened and extended the previous law, especially in the areas of enforcement, grants, and research.

The Water Quality Act of 1965 (Public Law 89-234) was approved on October 2, 1965. Pursuant to section 2 of the act, the Federal Water Pollution Control Administration was established in HEW on December 31, 1965. Previously, the Federal water pollution control program had been administered by the Division of Water Supply and Pollution Control, Bureau of State Services, Public Health Service, HEW.

The Water Quality Act authorized (1) grants for research and development of better methods for controlling pollution from combination storm and sanitary sewer overflows, (2) an increase in the amount of Federal grants for constructing waste treatment facilities, and (3) a program to establish water quality standards on interstate waters.

The administration of the water pollution control program, as well as most functions of the Secretary of HEW authorized by the Federal Water Pollution Control Act, as amended, was transferred to the Secretary of the Interior by Reorganization Plan No. 2, which became effective May 10, 1966. (FWPCA and its predecessor agencies will be referred to hereinafter as FWPCA.)

On November 3, 1966, the Federal Water Pollution Control Act was further amended by the enactment of the Clean Water Restoration Act (Public Law 89-753). That act expanded the scope of the research and development program established by the Water Quality Act of 1965.

CONSTRUCTION GRANT PROGRAM

The purpose of the Federal Water Pollution Control Act is to enhance the quality and value of the Nation's water resources and to establish a national policy for the abatement, control, and prevention of water pollution. The act authorizes FWPCA to award grants to any State, municipality, or intermunicipal or interstate agency for the construction of necessary treatment facilities to prevent the discharge of untreated or inadequately treated sewage or other waste into any waters.

The act states that funds appropriated for construction grants are to be allocated to the States and territories on the basis of population and per capita income. The following table shows the amounts authorized and appropriated for construction grants during fiscal years 1957-69.

Fiscal year	Authorized	Appropriated
1957	$ 50,000,000	$ 50,000,000
1958	50,000,000	45,657,000
1959	50,000,000	46,816,000
1960	50,000,000	46,101,000
1961	50,000,000	45,645,260
1962	80,000,000	80,000,000
1963	90,000,000	90,000,000
1964	100,000,000	90,000,000
1965	100,000,000	90,000,000
1966	130,000,000	121,000,000
1967	150,000,000	150,000,000
1968	450,000,000	203,000,000
1969	700,000,000	214,000,000
Total	$2,050,000,000	$1,272,219,260

During fiscal years 1957 through 1967, Federal grants for the construction of waste treatment facilities were limited to 30 percent of the estimated reasonable cost of the project, subject to certain dollar limitations. Subsequent to June 30, 1967, there has been no dollar limitation on the amount of a Federal grant. The following table shows the maximum dollar limitations which the Congress set for Federal grants during the various periods.

Period	Percent	Maximum limitations: Individual projects	Maximum limitations: Multi-municipal projects
July 1, 1956 to June 30, 1961	30	$ 250,000	$ 250,000
" " 1961 to " " 1965	30	600,000	2,400,000
" " 1965 to " " 1967	30	1,200,000	4,800,000
After June 30, 1967	30	No limit	No limit

Federal participation in the cost of waste treatment facilities may be increased to 40 percent if the State agrees to pay not less than 30 percent of the cost of all projects within the State receiving Federal grants. Federal participation may be further increased to 50 percent if the

State agrees to pay not less than 25 percent of the cost of all projects receiving Federal grants and if enforceable water quality standards have been established for the waterway. Also, Federal participation may be further increased by as much as 5 percent if the project is in conformity with a metropolitan plan for the area concerned. Thus a Federal grant may be for as much as 55 percent of the eligible project costs. Appendix IX shows the States that have matching grant programs and the percentages of project costs eligible for State grants.

During fiscal years 1957 through 1969, FWPCA, through its construction grant program, awarded grants of about $1.2 billion for the construction of more than 9,400 projects having a total estimated cost of about $5.4 billion. Appendix X shows the amount of construction grant funds allocated to the States and the grants awarded during fiscal years 1957 through 1969.

WATER POLLUTION AND WASTE TREATMENT PROCESSES

The necessity for waste treatment facilities depends largely upon the water quality or water uses desired on a waterway or segment thereof. Water pollution is normally considered to exist when the waters are below the quality levels established by the States or when the waters cannot be used for the purposes desired.

In its "Guidelines for Establishing Water Quality Standards for Interstate Waters," FWPCA states that all wastes, prior to discharge into any interstate water, are to receive the best practical treatment or control unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with proposed present and future water uses.

The conventional waste treatment process is usually considered to consist of two steps--primary treatment and secondary treatment. Primary treatment involves (1) the removal of suspended and settleable solids by flotation and sedimentation and (2) chlorination of the effluent. Primary treatment plants normally reduce the biochemical oxygen demand (BOD)[1] by about 35 percent, through removal of about 50 percent of the suspended solids and of about 90 percent of the settleable solids. Where the flow of the receiving stream is high in relation to the quantity of sewage contributed, the primary treatment process is sometimes sufficient to safeguard public health and to prevent the development of nuisance conditions. However, additional treatment beyond primary treatment is usually required, especially in instances where the receiving streamflow may be low or where pollution loads are exceptionally high.

---

[1] BOD is a measure of the strength of sewage in terms of the amount of oxygen required to sustain decomposition of the waste by bacteria.

Secondary treatment involves the aerobic decomposition[1] of the greater portion of the organic matter left in the effluent after the primary treatment process. Secondary treatment plants will normally remove from 80 to 95 percent of the total BOD and approximately 85 percent of the suspended solids. The presence of high industrial waste concentrations can be expected to reduce the removal of BOD and suspended solids if the plant is not properly designed and if careful control is not continually maintained over the treatment process.

Tertiary treatment involves a process beyond that of primary and secondary treatment. This process can remove substantially all the BOD and suspended solids but is mainly used for the removal of specific substances, such as phosphates.

A picture of a secondary treatment plant is shown on the next page.

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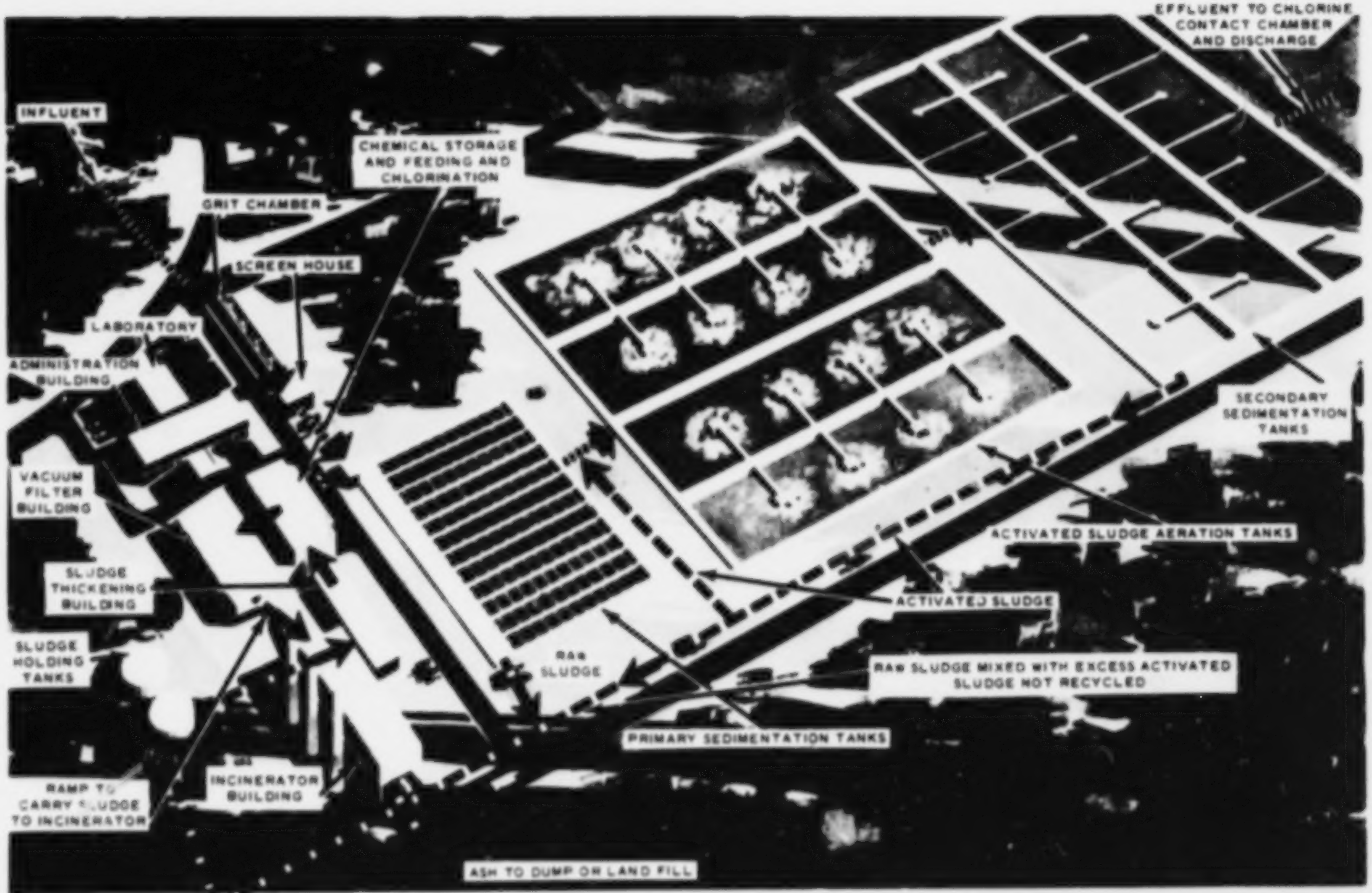
[1] Aerobic decomposition is the breakdown of organic matter in sewage by bacteria which grow only in an aquatic environment containing dissolved oxygen.


INFLUENT
CHEMICAL STORAGE AND FEEDING AND CHLORINATION
GRIT CHAMBER
SCREEN HOUSE
LABORATORY
ADMINISTRATION BUILDING
VACUUM FILTER BUILDING
SLUDGE THICKENING BUILDING
SLUDGE HOLDING TANKS
RAMP TO CARRY SLUDGE TO INCINERATOR
INCINERATOR BUILDING
EFFLUENT TO CHLORINE CONTACT CHAMBER AND DISCHARGE
SECONDARY SEDIMENTATION TANKS
ACTIVATED SLUDGE AERATION TANKS
ACTIVATED SLUDGE
RAW SLUDGE
RAW SLUDGE MIXED WITH EXCESS ACTIVATED SLUDGE NOT RECYCLED
PRIMARY SEDIMENTATION TANKS
ASH TO DUMP OR LAND FILL
= SLUDGE FLOW
= SEWAGE FLOW

SECONDARY TREATMENT PLANT

CHAPTER 2

CONCLUSIONS, RECOMMENDATIONS, AND MATTERS FOR CONSIDERATION BY THE CONGRESS

CONCLUSIONS

During fiscal years 1957 through 1969, FWPCA awarded grants of about $1.2 billion for the construction of more than 9,400 waste treatment projects having a total estimated cost of about $5.4 billion. Generally, these projects have contributed to abating water pollution because the water pollution problem would have been worse if these projects had not been constructed. We believe, however, that the benefits from the construction grant program have not been as great as they could have been, because many waste treatment facilities have been constructed on waterways where major polluters--industrial or municipal--located nearby continued to discharge untreated or inadequately treated wastes into the waterways. We believe that greater benefits could have been achieved if the Federal and State water pollution control agencies had more effectively coordinated the planning and construction of municipal and industrial waste treatment facilities on individual waterways.

The construction grant program to date has been administered for the most part using a "shotgun" approach--awarding grants on a first-come-first-served or readiness-to-proceed basis, with little consideration's being given to the benefits to be attained by the construction of individual waste treatment plants. This approach may have served a useful purpose in the early years of the program when there was a need to generate interest on the part of the States and communities to get the program moving. We believe, however, that this approach can no longer be justified and that there is a need to award grants on a more systematic basis giving consideration to the benefits to be attained.

Prior to fiscal year 1968, comprehensive programs used by FWPCA as a basis for awarding construction grants were essentially alphabetical listings of municipalities in each State that were in need of waste treatment facilities. Also State plans submitted to FWPCA prior to fiscal year 1968 generally did not include coordinated construction schedules to be met by industries and municipalities so as to attain specific objectives on individual waterways or sections thereof. As a result, we believe that neither the listings used by FWPCA as comprehensive programs nor the State plans as submitted to, and approved by, FWPCA represented meaningful plans for abating, controlling, and preventing water pollution.

Beginning in 1967, the States submitted water quality standards for their interstate waters and schedules for implementation of the standards. The water quality standards implementation schedules represented the first time-phased plans, on statewide bases, for the construction of waste treatment facilities by municipalities and industries to attain specific objectives on individual waterways. The implementation schedules are currently being used as one of the bases for State and FWPCA approval of Federal grants to municipalities for the construction of waste treatment facilities. Many of the States established 1972 as the year for attaining the water quality standards, which coincides with the date recommended by FWPCA.

In our opinion, however, a serious question exists as to the attainability of the standards by the dates in the implementation schedules because, due to Federal funding in amounts significantly less than the amounts which were authorized, construction is proceeding at a rate well below that which was anticipated. For fiscal years 1968 and 1969, Federal water pollution control legislation authorized $1.15 billion for the construction of waste treatment facilities. Of this amount, about $417 million was appropriated. Although Federal water pollution control legislation authorized $1 billion for fiscal year 1970, the proposed budget for the fiscal year provides for only $214 million for the construction grant program

We found that, although some States had moved forward without sufficient Federal funds by prefinancing the Federal portion of some projects, the majority of the States were constructing waste treatment facilities at a rate consistent with the availability of Federal funds. Both FWPCA and the States developed their programs and plans on the basis of the funds expected to be made available in the form of Federal construction grants--the amounts authorized. Since few States are proceeding with construction without Federal funds, there is, in several States, an ever-increasing backlog of municipalities awaiting Federal grants.

Furthermore, prior to 1967, the construction grant program provided incentives primarily to smaller municipalities in that the dollar limitations contained in the act represented a meaningful contribution to the costs of constructing smaller waste treatment facilities but did not provide a real incentive to the larger municipalities. In addition, we believe that such limitations did not encourage the construction of municipal waste treatment facilities capable of treating substantial quantities of industrial wastes.

The elimination of the dollar-limitation clause in 1967, however, has provided the incentive for many large municipalities that need multi-million-dollar waste treatment plants to participate in the construction grant program, which placed larger demands on Federal funds. Furthermore, there has been a growing trend toward the treatment of industrial wastes in joint municipal-industrial plants and, if this trend continues, it may well be that much of the costs for treatment facilities which are presently associated with industry will become eligible for Federal assistance. Another matter to be considered is the multi-billion-dollar cost associated with the combined storm and sanitary sewer problem.

On the basis of our examination into these matters; our discussions with Federal, State, and local officials; and the fact that most States are constructing treatment plants at a rate consistent with the availability of Federal funds, we believe that the present level of Federal funding will not be sufficient to enable a significant increase in the effectiveness of the program in abating, controlling, and preventing water pollution unless changes are made in the administration of the program.

In view of the magnitude of the water pollution problem and the limited Federal funds available, it appears to us that it will be many years before the construction grant program is completed. Thus we believe that interim goals or objectives should be established, whereby significant improvement in water quality and uses can be attained on some waterways or sections of waterways. The FWPCA requirement of secondary treatment may be desirable as the ultimate objective. We believe, however, that as an interim measure consideration should be given to less than secondary treatment when such treatment will result in enhancing water quality or in attaining the States' water quality standards. Not only should this result in better utilization of Federal funds, in that funds should be available for a greater number of grants, but also those municipalities that construct facilities for less than secondary treatment should realize substantial savings in annual operation and maintenance expenses. Municipalities that are allowed to provide less than secondary treatment should be advised that, if circumstances change as a result of population and/or industrial growth or expansion, they may be required to upgrade their treatment facilities.

Our review has shown that the requirement to provide secondary treatment and the construction of municipal waste treatment facilities primarily on the basis of readiness and willingness to proceed has not, in many cases, accomplished water quality improvement objectives. Our review has shown also that many municipalities that have incurred the expenses of constructing, operating, and maintaining waste treatment facilities have not realized the benefits anticipated as a result of the construction.

The States' water quality standards implementation schedules and the annual priority listings are based primarily on the readiness of municipalities to proceed with construction. We believe that such an approach relies heavily on completing the construction of all treatment facilities, including industrial, within a few years. The relative success or failure of such an approach is dependent on the time frame within which such construction is completed. If the time frame is 3 to 5 years, perhaps this approach will accomplish the program objectives reasonably well. However, if we are talking in terms of many years to complete the construction program, and we believe that it could be many years, such an approach may be inefficient and ineffective in substantially improving water quality or uses during the interim years.

A more effective approach, in our opinion, requires a coordinated and systematic effort on the part of FWPCA, the States, and all polluters in the planning and construction of waste treatment facilities in a manner that will achieve water quality objectives. We believe that the States, in establishing priorities, and FWPCA, in awarding grants, should consider the benefits to be derived from the construction of individual treatment facilities. FWPCA and State agencies should be able to choose from alternatives and establish priorities on the basis of the benefits to be attained.

We believe that the use of systems analysis techniques and mathematical models would be of substantial benefit to Federal and State decisionmakers. By utilizing systems analysis techniques, the results, in terms of improved water quality over the entire river, could be estimated for a single waste treatment plant or for combinations of plants. Furthermore, such techniques may provide a means of evaluating the desirability of changes in plans and priorities as construction phases are completed.

The use of systems analysis will aid FWPCA and State officials in making cost-effectiveness studies and estimating the least costly method of attaining water quality goals or objectives. It will also enable the officials to identify alternatives for consideration in assigning priorities and establishing construction schedules that will result in the achievement of significant benefits.

We believe that the use of systems analysis techniques in planning and implementing water pollution control programs is both feasible and practicable. We believe also that the use of systems analysis concepts and techniques by FWPCA and the States to aid in managing their pollution abatement programs should lead to improving the effectiveness of the construction grant program and of controlling water pollution.

We believe that the adoption of systems analysis methods in planning and implementing water pollution control programs could be done with few changes in the present legislation. In particular, the single most important change desirable is in the manner of awarding Federal grants. The present system requires that consideration be given to financial and water pollution needs in establishing priorities. We believe that a priority system based on benefits to be attained merits consideration. We believe that a major reorganization in the current program would not be necessary in order to utilize such a method since most of the prerequisites for its implementation already exist.

In our opinion, a considerable amount of the data and computer capability needed in employing the techniques of systems analysis is available or could be made available by utilizing FWPCA's STORET system and computer. (See p. 96 .) The additional data needed could be collected by the State water pollution control agencies, FWPCA and/or other Federal and regional agencies, as appropriate. This data could then be analyzed by FWPCA, or perhaps a consulting engineering firm, and included in the STORET system. State or interstate authorities could draw upon the system for data in planning the establishment of construction priorities in order to achieve specific water improvements.

Methods such as those outlined above could be used by FWPCA in the development of its comprehensive programs; in evaluating State water quality standards, implementation schedules, and applications for construction grants; and in FWPCA's surveillance programs.

We do not mean to imply that the use of systems analysis will automatically solve all the problems associated with the water pollution control program. Rather, the largely quantitative results of systems analysis should be used in conjunction with other information available to responsible officials in making decisions.

Political and institutional constraints have adversely affected the water pollution control program in the past and probably will continue to do so in the future. Such constraints include the failure of municipalities to authorize bond issues to fund the municipalities' share of construction costs; insufficient numbers of trained personnel at the Federal, State, and local levels; insufficient funding at all levels; and the fact that water pollution has no political or geographical boundaries, in that the actions of one municipality or State affect other municipalities and States.

We believe that FWPCA and the States must find ways to overcome these constraints if the program is to become more effective. We believe that more consideration could be given to planning and implementing water pollution control programs on a river basin basis or to administering the construction grant program through a State agency which would be responsible for planning, designing, constructing, operating, and maintaining of all waste treatment facilities within the State.

RECOMMENDATIONS

We recommend that the Secretary of the Interior require that the States, in establishing priorities for the construction of waste treatment facilities, and FWPCA, in approving Federal grants for such construction, give consideration to (1) the benefits to be derived from the construction of the facilities and (2) the actions taken, or planned to be taken, by other polluters of the waterway. We believe that the application of systems analysis techniques would assist State and FWPCA water pollution control officials in establishing priorities and approving grants on the basis of the benefits to be attained, which should result in improving the effectiveness of the water pollution control program. Accordingly, we recommend also that FWPCA consider utilizing systems analysis techniques in the planning for and implementing of water pollution control programs.

We recommend further that FWPCA consider the practicability of providing, through its STORET system, data needed by the States in (1) determining their water pollution control requirements, (2) identifying alternatives available to solve water pollution problems, (3) formulating water pollution control plans, and (4) establishing implementation schedules and priorities for the construction of waste treatment facilities.

MATTERS FOR CONSIDERATION BY THE CONGRESS

Section 8(a) of the Federal Water Pollution Control Act provides that:

> "*** no grant shall be made for any project under this section unless such project *** has been certified by the appropriate State water pollution control agency as entitled to priority over other eligible projects on the basis of financial as well as water pollution control needs."

On the basis of our review, we believe that priorities should be established on the basis of benefits to be attained and that a coordinated effort is required on the part of all polluters of a waterway to attain the maximum benefits from the construction grant program. We believe that the requirement in the act that financial need be a factor in establishing priorities could result in FWPCA's awarding grants for the construction of projects which provide little benefit in terms of appreciably improving water quality or uses.

Accordingly, and in view of (1) the magnitude of the program required for the construction of waste treatment facilities and (2) the backlog of grant applications for Federal funds, the Congress may wish to consider amending section 8(a) of the act to provide that priorities for grant awards be established on the basis of the benefits to be realized.

Although the Department of the Interior has agreed with our basic premise that a more systematic means of awarding construction grants must be found to secure greater benefits in pollution abatement, and has agreed with the recommendations set forth in this report, it has taken the position that providing for less than secondary treatment of wastes would not be acceptable and that interim goals should not be established. We continue to believe that interim goals should be established and that the providing of less than secondary treatment would be desirable under certain circumstances as discussed on page 16 of this report.

Accordingly, we recommend that the Congress consider requiring the Department of the Interior to provide for interim goals and to allow communities to construct less than secondary treatment facilities when it can be demonstrated that a lesser degree of treatment will result in water quality enhancement commensurate with proposed present and future water uses.

CHAPTER 3

FEDERAL AND STATE WATER POLLUTION CONTROL PROGRAMS AND PLANS

Federal and State planning for water pollution control is emphasized in the Federal Water Pollution Control Act as being a prerequisite to the approval of Federal grants to municipalities and other political subdivisions (hereinafter referred to as municipalities) for the construction of waste treatment facilities. Also, the act requires each State to certify that the individual projects which are to receive grants are entitled to priority over other eligible projects on the basis of financial and water pollution needs.

Our review showed that, prior to fiscal year 1968, effective planning for the award of Federal grants for the construction of waste treatment facilities did not exist at either Federal or State levels. Subsequent to the enactment of the Water Quality Act, water quality standards plans were submitted to FWPCA by the States, which established water quality objectives and construction implementation schedules to achieve these objectives within a specified time frame. As a result, the planning at the State and Federal levels was improved.

FEDERAL COMPREHENSIVE WATER POLLUTION CONTROL PROGRAMS

Section 3 of the Federal Water Pollution Control Act requires the Secretary of the Interior, in cooperation with other Federal agencies, State water pollution control agencies, interstate agencies, municipalities, and industries involved, to develop comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. In developing such comprehensive programs, the Secretary is required to consider improvements which are necessary to conserve such waters for public water supplies; propagation of fish and other aquatic life and wildlife; recreational purposes; and for agricultural, industrial, and other legitimate uses.

The act also states that no grant shall be made for constructing a waste treatment project unless the project has been approved by the appropriate State water pollution control agency and by the Secretary and unless such project is included in a Federal comprehensive program developed pursuant to the act.

Our review showed that, prior to fiscal year 1968, such Federal comprehensive programs were essentially alphabetical listings, prepared by the States, of all municipalities in each State that were in need of, or might be in need of, waste treatment facilities in the foreseeable future. The listings were published in the Federal Register in November 1956 and were revised periodically to add municipalities not included initially. According to officials in several States that we visited, all municipalities which might need a waste treatment facility in the foreseeable future were placed on the listing so that they would be eligible for Federal assistance.

In March 1967, the Acting Assistant Commissioner for Program Plans and Development, FWPCA, indicated that there might be a need for substituting comprehensive programs for the existing listings published in the Federal Register. In May 1967, the Assistant Commissioner, Comprehensive Planning and Programs, FWPCA, in commenting on this matter stated:

> "*** put in the Federal Register a statement describing how we are going to comply with the law which requires that construction projects conform to a comprehensive program developed under our Act. This procedure, would, in effect, state that as the comprehensive plans prepared under Section 3 (a) and 3 (c) of the Act become available and are approved by the Commissioner, such plans would be the basis for granting Federal funds for construction projects."
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> *　*　*　*　*
>
> "The statement to be inserted in the Federal Register would make reference to the fact that the goal of such comprehensive planning and

> implementation plans is to develop comprehensive programs against which we can determine the progress that we are making through Federal support of the construction of treatment facilities."

In July 1967, the Commissioner of FWPCA, in a memorandum to the Director, Division of Construction Grants, referred to the section of the act which requires that no grant be approved for a waste treatment project unless the project is included in a comprehensive program developed pursuant to the act, and stated, in part, that:

> "For the first ten years of the construction grant program the *** requirement of the law has been complied with largely by resorting to fiction. In 1956, lacking any comprehensive plans developed under the law, the Surgeon General deemed as constituting comprehensive plans, lists prepared by the states of communities in need of sewage treatment facilities. If an applicant city was on its state's needs list, its proposed treatment plant was presumed to be included in a comprehensive program, and the requirements of Section 8(b)(2) met."
>
> "*** The key fact is that ten years after the program started, we have developed comprehensive plans under Section 3(a) of the law on one river and one estuary. Even at a greatly accelerated pace and a streamlined procedure *** it will, unfortunately, still take a few years before something resembling a nation-wide comprehensive plan can be produced. Most unfortunately, these years will be the very years when our construction program will be functioning at full steam."

The Commissioner than proceeded to outline procedures which, on January 24, 1968, were published in the Federal Register and incorporated in section 601.25(c) of title 18 of the Code of Federal Regulations. On January 17, 1968, the listings of locations published in the Federal Register in 1956 and the subsequent amendments thereto were rescinded with a notation to the effect that the determination of whether waste treatment projects had been included in comprehensive programs prepared or developed pursuant to section 3 of the act should be made in accordance with 18 CFR 601.25(c) which states that:

> "*** A project shall be deemed to be included in such comprehensive program if:
>
> (1) Such project is included within a comprehensive program developed pursuant to section 3 *** or
>
> (2) Such project is compatible with a comprehensive program being developed pursuant to section 3 *** or
>
> (3) Such project is not in an area for which a comprehensive program has been or is being developed pursuant to section 3, but such project is not inconsistent with the following factors: Water quality standards established pursuant to the Federal Act, for the waters into which such project shall discharge, or with the State plan for the prevention and control of water pollution approved for the State in which such project is located pursuant to section 7 of the Federal Act, or the recommendations of the Secretary, a hearing board, or orders of any court pursuant to section 10 of the Federal Act applicable to the waters into which such project will discharge: Provided, that no grant shall be made for any project which is inconsistent with the factors mentioned in sub-paragraph (3) of this paragraph."

For the purpose of developing the comprehensive programs which are required by section 3 of the act, FWPCA divided the Nation into 20 major drainage areas consisting of approximately 210 river basins. During the period 1956 to 1968, FWPCA initiated comprehensive studies in 15 of the drainage areas and expended about $33 million on comprehensive planning activities.

In a memorandum dated December 2, 1966, the Commissioner, FWPCA, characterized the comprehensive studies as consisting of lengthy fieldwork which emphasized the obtaining of data and the development of long-range technical solutions of pollution problems. He said that, in a few basins where remedial measures were defined, inadequate institutional arrangements to carry out the needed water pollution abatement programs were a major problem.

During our review an FWPCA official informed us that the initial studies did not emphasize the development of action plans for abating water pollution in the major drainage areas. This official stated that data collected from the studies was used for such purposes as support for many Federal enforcement actions and development by the States, and review by FWPCA, of interstate water quality standards.

FWPCA officials informed us that, in 1967, the comprehensive programs were redirected to place more emphasis on developing pollution control action plans for use in accomplishing intermediate and long-range water pollution control objectives on the various river basins.

As of July 1969, the following five reports had been issued by FWPCA as a result of its comprehensive studies.

1. "Willamette River Basin Water Quality Control and Management," January 1967.
2. "Water Pollution Problems of Lake Michigan and Tributaries," January 1968, revised June 1968.
3. "Water Pollution Problems and Improvement Needs, Lake Ontario and St. Lawrence River Basins," June 1968.
4. "Lake Erie Report, A Plan For Water Pollution Control," August 1968.
5. "Water Quality Control and Management, Snake River Basin," September 1968.

An FWPCA official informed us that two additional reports, based on studies of the Susquehanna River and on Lake Huron, are in draft form and have been submitted to FWPCA headquarters for policy review. He informed us also that FWPCA planned to issue reports on 25 additional river basins during fiscal year 1970 and that planning studies of 36 river basins would be in process during fiscal year 1971.

The Clean Water Restoration Act of 1966 amended the Federal Water Pollution Control Act by authorizing the Secretary of the Interior to award grants to planning agencies to assist them in the development of comprehensive pollution control and abatement plans for river basins. To assist prospective grantees, FWPCA prepared and distributed "Guidelines for Grants--Comprehensive River Basin Planning" to State, local, and interstate pollution control agencies. The purpose of this program, as stated in the guidelines, is to support the development of comprehensive pollution control plans which provide action programs to achieve water quality objectives for river basins or portions thereof.

To carry out this program, the Congress appropriated $500,000 in fiscal year 1968 and $1,250,000 in fiscal year 1969. As of July 1, 1969, FWPCA had awarded grants totaling $1,122,275 to 10 planning agencies. In addition, the San Francisco Bay-Delta Study--one of the planning studies initiated--had been completed and a report issued in March 1969.

STATE WATER POLLUTION CONTROL PLANS

Prior to fiscal year 1968, the water pollution control plans of the eight States included in our review generally did not set forth specific objectives, did not provide plans of action to meet specific objectives, or did not include coordinated construction schedules to be met by industries and municipalities so as to attain specific objectives on individual waterways or sections thereof.

The plans submitted to FWPCA by the States were generally narrative presentations covering 1 or 2 fiscal years and set forth such matters as the organization and authority of the State agency; water pollution control policies and general objectives; descriptions of the State's program; proposed legislation; priority systems for determing financial and water pollution control needs; descriptions of the budgetary and accounting methods to be followed; and, in some instances, listings of municipalities in need of waste treatment facilities.

FWPCA guidelines, developed to assist the States in preparing their fiscal year 1968 plans, required the States to develop, as part of their plans, a priority list of treatment facilities which must be constructed to meet current needs. In fiscal year 1968, seven of the eight States included in our review submitted, as part of their plans, listings of the proposed construction of municipal waste treatment facilities with priorities assigned, on the basis of points, for financial and water pollution control needs.

In accordance with the Water Quality Act of 1965, seven of the eight States submitted water quality standards (see p. 34) and schedules which showed the dates by which the water quality standards were to be implemented. The implementation schedules represented time-phased plans of action, considering the actions which would be required by both municipalities and industries, to meet the water pollution control objectives for individual waterways. Most of these States included in their fiscal year 1969 plans a listing of municipal waste treatment facilities planned for construction in the ensuing 5-year period.

During our review, we found that the States were actually pursuing water pollution control in a variety of ways. Some of the States in one FWPCA region had, under the auspices of an interstate agency, concentrated on classifying interstate waterways on the basis of present and future uses. In classifying waterways for future uses, the States usually considered (1) present uses, (2) sources and types of wastes, (3) assimilative capacity of the waterways, (4) desired uses, and (5) costs to attain the desired uses.

Once the classification program was completed for a waterway, the individual States were responsible for obtaining compliance from industries and municipalities. According to officials in two of the three States we visited in this region, orders were issued to municipalities and industries advising them of the actions which they were to take to abate, control, and prevent water pollution. These officials informed us, however, that the States were able to get only limited compliance with the orders. As a result, Federal grant funds were generally provided to those municipalities who were ready and willing to proceed.

In a second region, one State permitted the discharge of wastes without treatment as long as the water receiving the wastes could assimilate them without adversely affecting downstream uses. In 1961, this State found it necessary, due to population and industrial growth, to revise its policy to provide for removal of as much pollution as practicable. Although this State had adopted water quality criteria for specific water uses, it had not classified its waterways for specific uses. We found that the State, on occasion, had assigned a usage classification to a waterway when it found that the quality of the water had deteriorated below the level required for present uses. Therefore from 1961 through 1967 the general approach to controlling water pollution in this State was to treat as much waste as practicable.

In a second State in this region, officials informed us that in 1952 the State developed water pollution control programs for its major river basins. These programs generally described the desired uses of the waterways, the nature and locations of sources of pollution, and the improvements considered necessary. These officials, however, characterized the program, prior to 1967, as a plan primarily of "putting out fires," rather than a long-range plan of implementation. According to these officials, the State emphasized (1) solving the more significant pollution problems and (2) helping those municipalities voluntarily applying for Federal grants to construct facilities. The development of the water quality standards plan in 1967 resulted in the State's establishing, for the first time, a long-range planning effort, including a time-phased schedule for the construction of waste treatment facilities.

In a State in the third region we visited, one State agency administered the Federal grant program for the construction of municipal waste treatment facilities and another State agency administred the program for construction of industrial waste treatment facilities. At the beginning of the construction grant program in July 1956, the State submitted a register to FWPCA listing all of the municipalities that it believed would need sewage treatment plants in the future, including those with no sewerage, to ensure the eligibility of the municipalities for future Federal grants. Such a listing made it appear that almost every community in the State needed waste treatment facilities. Federal grants in this State have been awarded primarily to those municipalities which were ready and willing to proceed.

Toward the latter part of a fiscal year, when the amount of available Federal grant funds had decreased, the State solicited applications from those municipalities which it believed were ready and willing to proceed. We found that no attempt had been made by the State to coordinate the timing of the construction of municipal waste treatment facilities with the construction of industrial waste treatment facilities. This State's approach to water pollution control is mainly to protect the present uses of the waters as opposed to increasing water uses. In its water quality standards plan, the State requires municipalities and industries to comply with the requirement of secondary treatment of wastes, or its equivalent, by 1972.

Priority systems for approving projects for FWPCA grants

The Federal Water Pollution Control Act of 1956 requires each State to certify that individual grant projects are entitled to priority over other eligible projects on the basis of financial and water pollution needs. In 1961, the act was amended to provide that the criteria used by a State in establishing priorities be included in the State's plans submitted pursuant to the act.

Our review showed that a variety of priority systems were included in the plans of the States. By 1958, five of the eight States we visited had some form of priority system included in their plans. Six of the States had, in their fiscal year 1963 plans, systems whereby points were assigned to municipalities for factors such as water pollution and financial need. The remaining two States had included priority criteria in their plans by 1968.

The criteria contained in the State priority systems are basically concerned with three factors: (1) water pollution control need, (2) financial need, and (3) readiness and willingness of the municipalities to proceed.

Our review of the priority systems, whereby points were assigned to municipalities by the States on the basis of water pollution and financial need, showed that such systems had been used in four of the eight States from at least 1960, in one State from 1963, and in the remaining three States from 1968. The priority listings submitted by most of these States from 1967 included only those municipalities that (1) had submitted applications for construction grants or (2) the States expected would submit applications during the year. The municipalities were listed in the order of total points assigned. Because the priority systems were applied, in most cases, to only those municipalities filing applications for a grant or considered likely to file applications, the priority listings generally represented only those municipalities that were ready to proceed.

In one region, a State that had a priority system from 1957 assigned points as follows:

	Points
Financial need	25
Pollution problem	65
Interstate waterway	10
Total possible points	100

The State considered projects for Federal grants on the basis of readiness to proceed, applications on hand, and the availability of Federal grant funds. In fiscal year 1968 for example, of 30 projects contained on the State's priority listing of construction planned for 1968, six municipalities, listed by the State as priorities 1, 5, 6, 7, 9, and 15, were awarded grants. Four municipalities not on the original list also received grants--three having been added during the year by an amendment to the listing. The fourth municipality was not included on the original or the amended listing. The remaining 24 municipalities on the listing either had not submitted applications, were not ready to proceed, or were not able to obtain a grant because of the unavailability of Federal grant funds.

In a State in another region, no priority criteria were included in its plan until fiscal year 1964. In its fiscal year 1964 plan, points were established for priorities as follows:

	Points
Financial need	40
Pollution problem	60
Total possible points	100

If the municipality had received a Federal grant in the past, 10 points were deducted.

In its fiscal year 1967 plan, the State commented that it would use the above criteria when Federal funds were not sufficient to fund all applications. The priority criteria were not applied until 1968. Projects to be funded with Federal grants were approved on the basis of (1) readiness of the municipality to proceed, (2) the applicant's being on the listing of municipalities needing treatment facilities, and (3) the availability of Federal grant funds. Although the priority system was applied in 1968, Federal grants to municipalities were approved by the State primarily on the basis of the availability of Federal grant funds and the readiness of municipalities to proceed.

In a third State, priority criteria have been utilized since 1957 on the basis of the following point system:

	Points
Financial need	20
Pollution problem	80
Readiness to proceed	60
Total possible points	160

The priority system is based on applications submitted, or expected to be submitted, with considerable emphasis' being placed on readiness to proceed, as indicated by the assigning of a possible 60 points to that factor.

In another State, officials informed us that an attempt to adhere to a priority listing was very difficult, even when the priorities were established primarily on the basis of the municipalities considered in the best position to proceed. As a result, the priority listing had to be continually revised. In the opinion of one official, the priority system for awarding Federal grants had been, and continued to be, of little value.

Our review showed that, under the existing priority systems, municipalities which were in dire financial need oftentimes did not submit applications and, as a result, generally were not considered for Federal assistance and would not be considered until applications were submitted, regardless of their pollution problems.

Water quality standards plans

The Water Quality Act of 1965 provided that water quality criteria applicable to interstate waters and a plan for implementation and enforcement of the criteria were to be adopted by the States before June 30, 1967. Guidelines for establishing such standards were issued by FWPCA in May 1966. The guidelines stated:

> "*** no standard will be approved which does not require all wastes, prior to discharge into any interstate water, to receive the best practicable treatment or control unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with proposed present and future water uses."

Additional guidelines, dated December 5, 1966, set forth the necessary supporting material and implementation plan contents. The section dealing with the implementation and enforcement plan states:

> "*** The statement of waste treatment or control needs must include:
>
> "*** A description of necessary improvements in waste water collection, control and treatment to achieve compliance with standards. If the proposed improvements are less than the best practicable treatment or control, detailed information justifying a lesser degree of treatment or control to meet the purposes of the Water Quality Act of 1965 must be presented."
>
> "*** Standards will not be accepted which do not provide for abatement of all existing conventional municipal and industrial pollution within approximately five years. Remedial measures planned for more complicated pollution, such as that from combined sewer overflows, might reasonably be scheduled for a longer period; e.g., five to ten years."

The Secretary of the Interior, in testifying before the Subcommittee on Air and Water Pollution, Senate Committee on Public Works, in March 1968 stated that the Department of the Interior was seeking, and for the most part the States were making, commitments to provide secondary treatment for all municipal waste within the next 5 years.

As of June 30, 1969, the water quality standards of the 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam had been approved by the Secretary of the Interior. The standards of 21 States, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam were approved by the Secretary without exceptions. The standards of 29 States were approved with certain exceptions. (See app. XI.)

The water quality standards of the eight States included in our review were approved by the Secretary, three with exceptions, between July 1967 and September 1968. The water quality standards plans generally consisted of (1) policies and laws, (2) water quality criteria, (3) classifications assigned to waterways, (4) plans for implementation, including time schedules for constructing waste treatment facilities by municipalities and industries, and (5) plans for enforcement of the standards.

Five of the States developed their water quality standards plan with the primary objective of protecting the present water uses. The other three States prepared their plans with the general objectives of providing for additional water uses. Four of the five States, in seeking to protect the present water uses, established 1972 as the year for attaining the water quality standards. The fifth State did not set up a time schedule. One of the three States, in seeking to provide for additional water uses, established 1974 as the year for attaining the water quality standards and the remaining two States established 1976 and 1977 as the years for attaining the water quality standards.

Of the eight States, (1) two had State grant programs to supplement the Federal construction grant program prior to 1967, (2) three States had instituted grant assistance programs in 1967 and 1968, (3) two States did not have grant programs at the time of our review, and (4) the remaining State had a grant program authorized but had not appropriated any funds. (See app. IX.)

We found that, in the development of the time schedules for construction of waste treatment facilities by municipalities and industries, a variety of factors had been considered by the seven States which had developed such schedules. The primary factors considered included the readiness of municipalities to proceed, the complexity and size of the projects, the availability of Federal grant funds, and a 1972 completion date. For example, the primary considerations of one State were:

1. A 1972 completion date.
2. The scheduling of larger projects toward the end of the implementation period.
3. The use of voluntary-compliance schedules submitted by some municipalities.
4. The availability of Federal grant funds.
5. The readiness of municipalities to proceed.

A second State considered the size and complexity of the projects; the readiness of municipalities to proceed, particularly with regard to financing; and a 1972 completion date. A third State considered the readiness of municipalities to proceed; the complexity of projects; the availability of Federal assistance, on the basis of authorized amounts; a 1972 deadline for start of construction; and other factors, such as the geographical location and enforcement conferences. Most of the States indicated that the construction of municipal waste treatment facilities would proceed at rates consistent with the amount of Federal assistance available.

The time schedules for implementation of the States' water quality standards were the first time-phased plans on statewide bases for the construction of waste treatment facilities by municipalities and industries to attain specific objectives on individual waterways. In addition, the implementation time schedules are currently being used as one of the bases for State and FWPCA approval of Federal grants to municipalities for the construction of waste treatment facilities.

The State that did not submit a time-phased schedule for either municipalities or industries has required secondary treatment of wastes by municipalities since the 1920's. State officials informed us that, since all municipalities within the State provide secondary treatment of waste or its equivalent, there was no need for such a schedule and that no backlog for waste treatment facilities existed except the backlog related to expansion and replacement of existing facilities. State officials informed us, however, that there was too much variance in waste treatment requirements for industrial wastes for them to prepare a valid implementation schedule for industries. Treatment of industrial wastes, according to the State, will be guided by the:

1. Nature, significance, and character of the wastes.
2. Water quality requirements at the point of discharge.
3. Technology available to industry.
4. Economic considerations.
5. Any other factors deemed relevant.

Prior to 1967, seven of the eight States permitted construction of primary treatment facilities by municipalities. In preparing the water quality standards plans, however, six of the seven States required secondary treatment by municipalities, with the exception of certain municipalities located on coastal waters. According to officials of four of the States, this action was strongly influenced by FWPCA.

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Prior to fiscal year 1968, comprehensive programs used by FWPCA as a basis for awarding construction grants were essentially alphabetical listings of municipalities in need of waste treatment facilities. Also, State plans submitted to FWPCA prior to fiscal year 1968 generally did not include coordinated construction schedules to be met by industries and municipalities so as to attain specific objectives on individual waterways or sections thereof. As a result, we believe that neither the listings used by FWPCA as comprehensive programs nor, the State plans submitted to, and approved by, FWPCA represented meaningful plans for abating, controlling, and preventing water pollution. We believe also that the submission of the water quality standards plans in 1967 permitted FWPCA, for the first time, to evaluate project applications on the basis of information pertaining to water improvement objectives on individual waterways and State implementation schedules to achieve such improvements.

In our opinion, a serious question exists as to the attainability of the water quality standards by the dates in the implementation schedules because, due to Federal funding in amounts which have been significantly less than the amounts authorized, construction is proceeding at a rate well below that which was anticipated. For fiscal years 1968 and 1969, Federal water pollution control legislation authorized $1.15 billion for the construction of waste treatment facilities. Of this amount, about $417 million was appropriated. Although $1 billion has been authorized for fiscal year 1970 and $1.25 billion for fiscal year 1971, the proposed budget for fiscal year 1970 provides for only $214 million for the construction grant program.

Although some States have attempted to move forward without Federal funds by prefinancing the Federal portion of some projects, the majority of the States are constructing waste treatment facilities at a rate consistent with the availability of Federal grant funds. Officials of one State, for example, informed us that, in the past, actual construction of municipal waste treatment facilities had been dependent upon the availability of Federal grant funds and that, subsequent to 1957, very few muncipalities had constructed facilities without a Federal grant. They stated further that it would be extremely difficult to meet the deadlines in the State's 5-year implementation plan at present funding levels.

In the development of its 1967 implementation plan, one State provided for completion of its construction program by 1974 and estimated that Federal grant funds of about $12 million would be available and that projects costing about $22 million would be initiated during fiscal year 1968. Our review of FWPCA records showed that the State had been allocated Federal grant funds of about $5 million and that projects costing about $14 million actually had been initiated in the State during fiscal year 1968. In another State, an official expressed the opinion that the State's construction program would probably take another 10 years beyond the anticipated completion date of 1976, primarily because of the limited Federal funding.

Our comparison of several States' priority listings with the water quality standards implementation schedules showed that considerable differences existed between the municipalities listed on the priority listings and those scheduled to proceed in the same time frame in the implementation plan. For example, one State's implementation schedule indicated that 31 municipalities were scheduled to initiate construction during fiscal year 1969. Of these 31 municipalities, only nine appeared on the State's priority listing of 28 municipalities submitted for fiscal year 1969. Of the remaining 19 municipalities on the listing, 12 were scheduled to proceed with construction in earlier or in later years and seven had not been included in the State's water quality standards plans because they were located on intrastate waterways. The implementation schedule was developed primarily on a readiness-to-proceed basis. The priority listings were prepared on the basis of those municipalities that had actually submitted applications for grants or were expected to submit applications for grants in the near future.

The priority listing, in our opinion, represented a more current schedule of municipalities ready to proceed, to which points had been assigned for water pollution control and financial needs. Since the primary basis for approving applications in the past was also the readiness of municipalities to proceed, the use of priority listings had not led to a meaningful change in the procedures for authorizing Federal grants. A priority system that recognizes the water improvements and uses that can be expected to accrue upon completion of construction would, in our opinion, be more meaningful.

CHAPTER 4

MAXIMUM WATER QUALITY IMPROVEMENTS NOT OBTAINED AS A RESULT OF APPROACHES FOLLOWED IN THE PAST

During fiscal years 1957 through 1969, FWPCA awarded grants of about $1.2 billion for the construction of more than 9,400 projects having a total estimated cost of about $5.4 billion. Generally, these projects have contributed to abating water pollution, since the water pollution problem would have been worse if these projects had not been constructed. We believe, however, that the benefits obtained from the construction of the projects have not been as great as they could have been, because many waste treatment facilities have been constructed on waterways, where major polluters located nearby--industrial or municipal--continued to discharge untreated or inadequately treated wastes into the waterways. We believe that greater benefits could have been achieved if the Federal and State water pollution control agencies had more effectively coordinated the planning and construction of municipal and industrial waste treatment facilities on individual waterways.

The construction grant program to date has been administered for the most part using a "shotgun" approach--awarding grants on a first-come-first-served or readiness-to-proceed basis--with little consideration's being given to the benefits to be attained by the construction of individual treatment plants. This approach may have served a useful purpose in the early years of the program when there was a need to generate interest on the part of the States and municipalities to get the program moving. We believe, however, that this type of approach can no longer be justified and that there is a need to award grants on a more systematic basis, consideration being given to the benefits to be attained.

The following examples demonstrate that, as a result of the approaches followed in the past, many treatment facilities have been constructed which, because of pollution from other sources, have not had an appreciable effect on reducing the pollution or improving the water quality and uses of the waterways. These examples were developed as a result of our examination into selected waterways or segments of waterways located within the three FWPCA regions included in our review. These waterways were selected on the basis that (1) pollution existed and (2) FWPCA grants had been awarded for the construction of municipal waste treatment facilities.

EXAMPLE 1

One river, including its major tributary, flows for about 50 miles within one State and for another 10 miles in a second State before entering a large interstate river. According to a 1966 FWPCA report, domestic and industrial wastes have polluted nearly the entire length of the river since 1936. The actual condition of the river was classified as unsatisfactory by both FWPCA and the State in which most of the river traverses. Such a classification represents nuisance conditions. A 1967 FWPCA report referred to the river as "one of the most disgusting rivers in the country." We visited various locations on this river and found the river to be unsightly and foul smelling.

Municipalities A and B are the major sources of domestic wastes on the river, and municipality C is a minor source. The three municipalities have constructed waste treatment facilities which serve a combined population of about 90,000. Municipality A's secondary treatment facilities, now considered inadequate, were constructed many years prior to initiation of the Federal construction grant program. Between 1961 and 1965, municipalities B and C were awarded Federal grants totaling about $700,000 for the purpose of constructing secondary waste treatment facilities which were estimated to cost about $2.3 million. Since these facilities were placed in operation, the BOD has been reduced from about 90,000 population equivalents (PE)[1] to about 30,000.

The total BOD being discharged into the river from three paper mills, a grinding operation, a chemical firm, and a tannery amounts to about 140,000 PE. Of the total 170,000 PE being discharged into the river, about 65 percent emanates from industries located in municipality A. Other industries on the river account for about 15 percent, while the remaining 20 percent is from the domestic wastes of the municipalities. Industrial wastes, therefore, account for about 80 percent of the BOD being discharged into the river and represent the major reason why the river remains in a polluted condition.

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[1] The quantity of dissolved oxygen contained in a waterway during periods of low flow is a key factor to whether a serious pollution problem exists. Furthermore, when the amount of dissolved oxygen falls below a certain level, the waters may no longer be able to sustain desired fish life. As a result, the amount of oxygen-demanding wastes discharged into a waterway is a primary concern in controlling the level of dissolved oxygen in the water. The oxygen-demanding wastes are commonly referred to in terms of PE of BOD--a standard representing the average oxygen-demanding wastes contributed daily by one individual. The use of such an equivalent enables other than domestic wastes to be reflected in comparable terms, by converting pounds of BOD or oxygen-demanding wastes to PE of BOD. The purpose of treatment is to reduce the amount of BOD contained in the waste before it is discharged into the waterway. The ability of a waterway to accept a given quantity of BOD without its interfering with the desired uses of the waterway is referred to as its assimilative capacity. The assimilative capacity of a waterway is dependent on such factors as its volume of water, rate of flow, temperature, the dissolved oxygen content prior to discharge of the BOD, and its ability to absorb oxygen from the atmosphere.

The water quality standards established by the State in 1967 provided for most of the river to be used for recreational boating, for irrigation of crops, and as a habitat for wildlife and game fish. According to a State official, no increased uses can be expected for the river until adequate treatment is provided for the domestic and industrial waste being discharged into the river from municipality A.

According to the State's implementation plan, municipality A is scheduled to construct a secondary treatment facility, at an estimated cost of $2 million, and the industries in municipality A are scheduled to construct facilities that are to provide the equivalent of secondary treatment. The construction of all treatment facilities in municipality A is to be completed by 1972.

During our review, we found indications that municipality A planned to build two waste treatment facilities, at an estimated cost of about $17 million, that would treat both domestic and industrial wastes. These facilities would be eligible for FWPCA grants of about 50 percent of total construction costs. A State official informed us that the construction of facilities at municipality A was still scheduled for completion in 1972, even though there had been an eightfold increase in the estimated construction costs since the State's implementation plan was established. Furthermore, it appeared that substantial amounts of Federal funds might be used to solve the industrial waste problem on this river.

In our opinion, the construction of waste treatment facilities financed in part with Federal grants of about $700,000 in 1962 (municipality C) and early 1965 (municipality B) has resulted in little improvement in water quality, primarily because of pollution from sources at municipality A. In addition, municipalities B and C have been incurring operating costs for about 4 and 7 years, respectively, and will continue to incur operating costs for at least 3 more years before adequate treatment is provided for the domestic and industrial waste being discharged from municipality A.

The pictures on the next two pages show the river as it appeared in July 1969 in the vicinity of municipalities A and B.

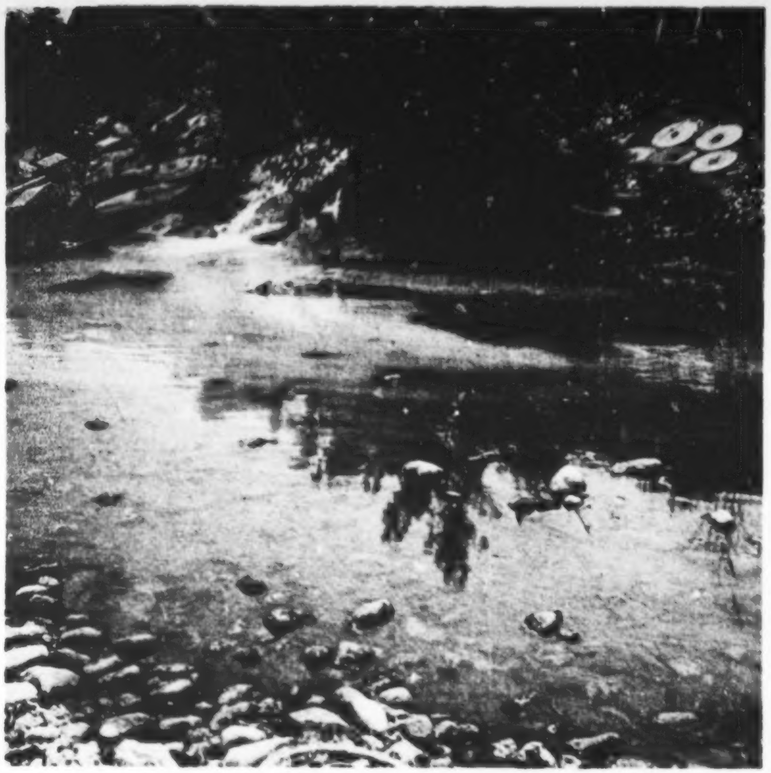

Figure 1

Figure 1 shows one of several outlets from an industry located in municipality A. At this point the river has an oily film and the bottom is covered with a green hair-like growth. The rocks in the background are covered with dried matter that can be picked up in sheets.

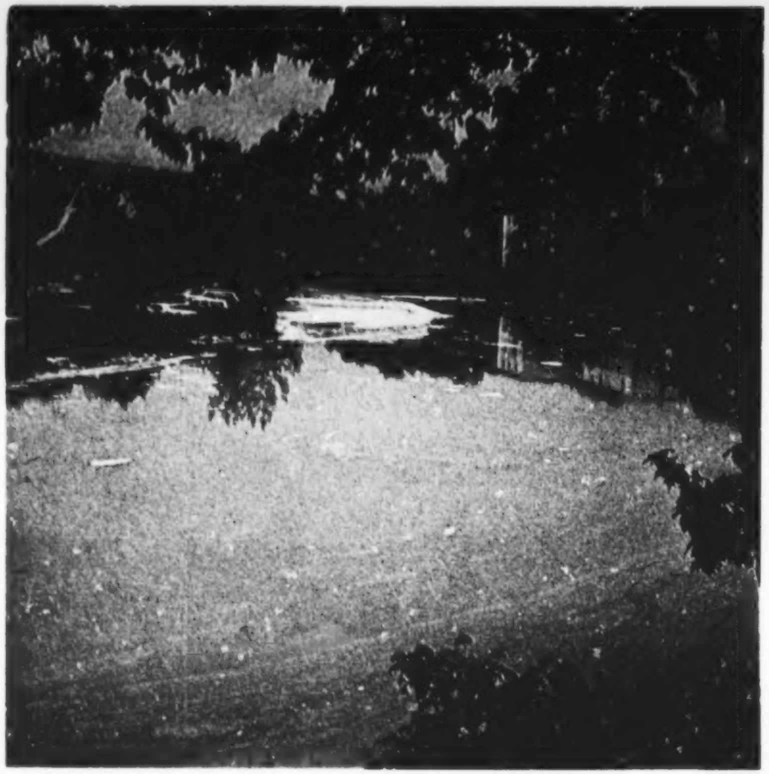

Figure 2

Figure 2 shows the river as it flows past one of the industries located in municipality A. A large raft of a reddish-white substance can be seen on the far bank of the river. There are a number of industrial plants located along a one-mile stretch of the river in the vicinity of municipality A.

Figure 3

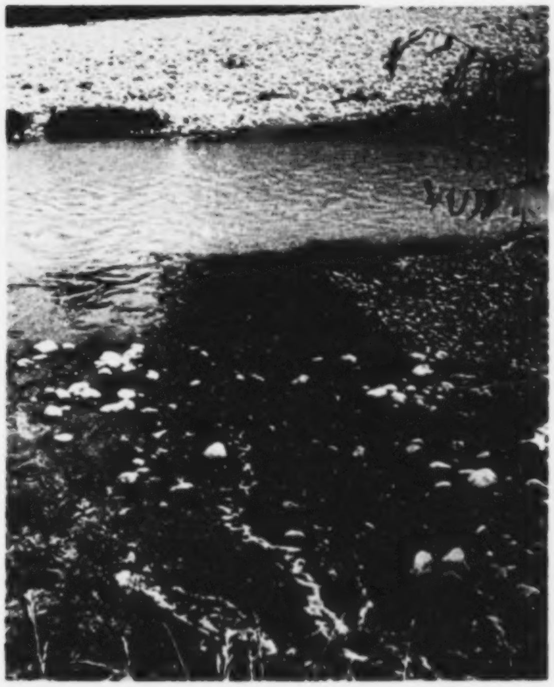

Figure 4

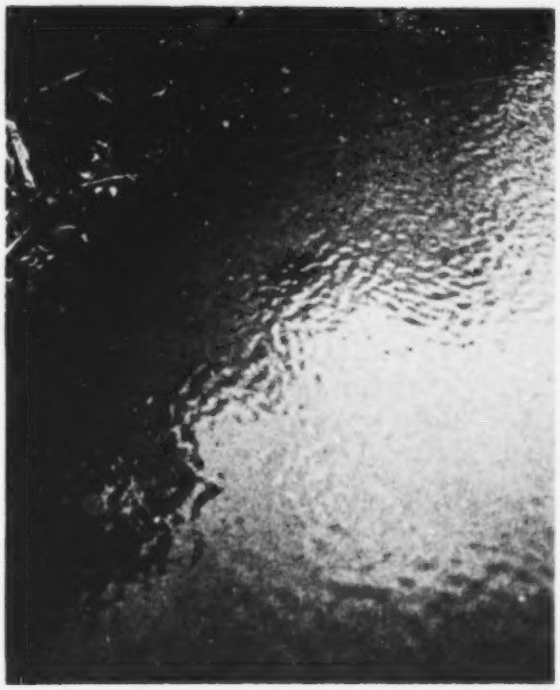

Figure 5

Figure 3 shows the river as it enters municipality B from municipality A. The river is discolored with mats of floating solids, and is extremely foul smelling. The sources of the pollutants in this area are municipal and industrial waste from municipality A.

Figure 4 shows clear effluent discharged from municipality B's sewage treatment plant as it enters the heavily polluted river. A clear line of demarcation is discernible.

Figure 5 shows the river about one mile downstream from municipality B's sewage treatment plant discharge and the river is still heavily polluted at this point.

EXAMPLE 2

An intrastate river, approximately 90 miles in length, flows into a large interstate waterway. In a 1969 report, FWPCA described the river as a meandering, sluggish stream where naturally occurring low flows during the summer are further depleted by the withdrawal of water to irrigate neighboring fields. The report stated also that the effluent from waste treatment plants severely affected the quality of the river by depleting the dissolved oxygen and adding nutrients which, in combination with sunlight and the warm, sluggish flow, yield large growths of slime and algae, degrading the aesthetic quality of the river.

The area surrounding the river and its tributaries has been rapidly developing and growing in population. All municipalities on this river and its tributaries have constructed secondary waste treatment facilities. According to FWPCA, these facilities have reduced the total estimated BOD load by approximately 90 percent. The main sources of industrial wastes--food-processing plants--are served by municipal waste treatment facilities. The treated waste water being discharged by municipal treatment plants, therefore, represents the residue after treatment of both domestic and industrial wastes.

During fiscal years 1957 through 1969, 21 Federal grants totaling about $2.6 million were made to municipalities located on the river and its tributaries to aid in financing the construction or enlargement of 13 waste treatment plants and numerous interceptor sewers and outfalls. According to a consulting engineer's report, there were 29 waste treatment plants discharging treated waste water into the river and its tributaries.

About 1956, local officials became concerned about the curtailment of growth and development along the river resulting from inadequate sewerage facilities. Three counties commissioned a local engineering firm to prepare a master plan to solve their sewerage problems on a tricounty basis.

The plan, completed on November 1, 1956, concluded, in part, that the tributaries of the river could not be considered other than temporary channels for final disposal of treated sewage because most of the tributaries would be dry in the summer except for treated waste water from waste treatment plants. The plan stated that these tributaries were in no way capable of accepting treated sewage, even from secondary treatment plants, without causing a measurable degree of pollution and resulting nuisance conditions.

Recognizing that individual small treatment plants which would discharge their effluent into the river and tributaries thereof would represent a considerable investment which would not provide a permanent answer to the problem, the engineering firm recommended that any "local" waste treatment plants be of a temporary nature and that approval of local sewerage systems be given only after proof that the system could be incorporated into the master plan. Instead of local treatment plants, the plan proposed that all wastes be transported out of the area to one large treatment plant which would discharge into a large interstate river. The cost of constructing interceptor sewers for the purpose of transporting the wastes from the area was estimated to be about $9,210,000, and the ultimate cost of the treatment plant was estimated to be about $10,000,000.

FWPCA officials stated that they did not officially recognize the master plan and never used it in evaluating applications for projects to be constructed on this river. However, in 1956, the State approved the plan as workable, after it had been adopted by the three counties. According to a county official, an informal organization made up of representatives of the three counties was formed to coordinate efforts to implement the plan. By 1961, a "temporary" treatment plant and an interceptor sewer which was to be incorporated into the master plan were constructed on a tributary of the river.

By 1962, according to a municipal official, municipalities that had delayed constructing their own facilities in anticipation of the master sewerage system began to doubt that an area-wide plan would ever be implemented. Many of these municipalities began to construct or enlarge their own facilities, often with the aid of Federal grants. The result was a number of small treatment plants discharging their effluent into the tributaries of the river.

As predicted in the 1956 tricounty master plan, this approach failed to solve the basin's pollution problems. On September 13, 1966, the State water pollution control agency emphasized the seriousness of the situation when it stated that, until a master plan was developed and adopted, construction of additional waste treatment facilities should not be approved in the river basin unless provisions were included to prevent the discharge of treated waste water into the river during periods of low flow, which normally occur between June and October.

This restriction led the county in which most of the river basin is located to engage a local consulting engineering firm to develop, once again, a master plan for waste treatment facilities in the basin. The plan was completed by the consulting engineering firm in January 1969 and differed from the earlier tricounty master plan in the following respects:

1. The plan included most of the area within the river basin, whereas the earlier plan covered only a portion of the basin.

2. The plan was concerned primarily with water quality rather than with area development.

3. The plan provided for a combination of advanced treatment plants, consolidation of plants, and river flow augmentation rather than for the transporting of all wastes out of the basin.

With regard to past efforts in the basin, the new plan stated that:

1. Solution to the sewerage problems in the study area has usually been the construction of sewers and treatment plants, treated waste water being discharged into streams which are practically dry in the summer. At the present time there are 29 waste treatment plants discharging into the river and its tributaries.

2. Many of the treatment facilities within the river basin have been constructed without regard to master planning and are inadequate to serve the needs of the entire tributary drainage basins.

3. The method used in solving local problems has created serious overall problems and has served to postpone and make difficult a true area-wide solution.

4. Although some of the treatment facilities have been designed to serve their entire local drainage area, many are inadequate and will require duplication or replacement in order to implement an areawide system.

We selected for review the projects constructed on one of the river's tributaries to determine whether such projects (1) had received FWPCA grants and (2) had been included in an FWPCA comprehensive program and were in conformance with the State water pollution control plan. Ten of the 21 FWPCA grants made in the basin were for projects which discharged their effluent into this tributary. The tributary, which is 14 miles long, is usually dry in the summer except for discharges from waste treatment plants. We examined in detail the three projects for which the most recent Federal grants had been made. The grants totaling $451,000 had been approved in fiscal years 1964, 1965, and 1967. The plants constructed in part with the three grants were designed to serve a combined population of about 45,600.

According to an FWPCA official, the three projects were approved as being included in a comprehensive program because they were included in a list of municipalities in need of waste treatment facilities, which was published in the Federal Register. Such lists, as discussed in chapter 3, merely identified municipalities in need of sewerage facilities in the State, in alphabetical order, and did not indicate the priority of projects.

In the grant applications, the three projects were certified by the State agency as being "in conformity with the State water pollution control plan submitted pursuant to section 5 of the Federal Water Pollution Control Act."

State plans for the fiscal years involved consisted essentially of an alphabetical listing of all the communities in the State in need of new or improved facilities. For each community, the listing included descriptions of the type of project needed, the population to be served, and the estimated construction cost. Our review showed that the three projects discharged treated waste water into the tributary, even though the 1956 master plan stated that the tributary could not assimilate treated waste water.

During our review all three plants were operating at or near capacity even though they were completed or expanded within the last 4 years. For example, one plant was originally completed in 1961 to serve as an interim facility until an area-wide system was implemented. By 1966, the plant was operating at or near capacity with the area-wide system still far from being implemented. An expansion which doubled the plant's capacity was undertaken and completed in 1968. But, at about the time the expansion was completed, the plant again became overloaded, and on June 28, 1968, the State agency placed restrictions on additional sewerage connections to the plant.

The 1969 area-wide plan, under consideration by the county at the conclusion of our site audit in June 1969, proposed that all three plants be abandoned and replaced with alternate facilities. In this regard, the plan described the tributary as "grossly polluted" and attributed this condition primarily to the large number of treatment plants discharging their effluent into the tributary.

FWPCA officials told us that Federal grants for projects were no longer being approved on the same basis as the three projects mentioned above. They informed us that, after July 1967, approval of grants for projects in the basin had been based on the projects' being in compliance with an FWPCA comprehensive report dated January 1967.

We examined into the application of the revised approval system by reviewing a project on the tributary which received an FWPCA grant in November 1968. According to an FWPCA official, the project, which was for an interceptor sewer, was in compliance with the FWPCA January 1967 comprehensive report. This official told us that, although the project was not specifically mentioned in the report, it was considered to be included because it was in conformance with the recommendation of the report that all treatment plants should achieve secondary treatment of their wastes. The FWPCA report recognized also the urgency of river flow needs and commented on the imminent necessity to develop a basin-wide program of pollution abatement and water quality maintenance for the river basin. The area-wide plan, presently under consideration by the county to meet this need, proposes the elimination of the treatment plant served by this interceptor sewer.

State, county, and local planning officials who are trying to solve the water pollution problem in this river basin on an area-wide basis stated that the primary reasons for following a localized, piecemeal approach were (1) the inability of the local people to form a unified managing entity to implement an area-wide solution to water pollution control and (2) a lack of funds at the local level necessary to finance such an approach.

In this river basin much of the tricounty area was underdeveloped in 1956 and the problem of local financing, which seemed to be the more acute problem, was explained as a dilemma by a county official in that

--funds for sewerage facilities were dependent upon an adequate property tax base for bonding capacity,

--an adequate property tax base for bonding capacity depended upon an area being fully developed,

--area development could not occur without adequate sewerage facilities.

The failure to form a unified managing entity also contributed to financing problems since it left the problem of raising the necessary funds for the construction of waste treatment facilities in the hands of the local municipalities which were faced with varying degrees of urgency regarding waste treatment facilities. An official of a regional planning agency informed us that the failure to form a coordinated managing entity was attributable primarily to inadequate State legislation governing such entities. The official stated that the existing law was deficient in three basic areas in that (1) any incorporated city could drop out of the entity at any time, (2) it provided for the entity to take over the entire system including existing collection systems, although in his opinion only the transportation and treatment of wastes were conducive to regional control, and (3) it did not provide for local representation in the control of the managing entity.

The following factors or conditions also were mentioned by local officials as contributing to the failure to implement the area-wide plan.

1. The funding of the Federal grant program was lower than had been expected.

2. The limitations on the size of the grant due to the emphasis on assisting small municipalities early in the Federal program.

3. City-county competition and lack of cooperation, possibly because of the belief that "local control" would be usurped.

4. Each small plant, as it was constructed, represented a capital investment and those who were served by the plant were reluctant to discard the plant.

In summary, this example shows that the uses of the river and its tributaries remain severely impaired, even after completion of facilities constructed in part with Federal grant funds. Acceptance by FWPCA of these projects as being included in a comprehensive program was, in our opinion, shortsighted because construction was generally initiated in response to local economic growth and development without adequate regard to the collective needs of all communities for enhancing water quality in the receiving waterways.

The results under this approach have subsequently prompted local officials to reconsider a master plan for the treatment of wastes. Similar to the master plan prepared in 1956, implementation of a new master plan will require a unified effort by all municipalities to adopt water pollution control measures. Implementation of such measures as consolidation of plants and flow augmentation will require solutions to the financial and institutional constraints that prevented adoption of a master plan in 1956.

If these constraints had been overcome earlier, the following could have been prevented: (1) delays in achieving full public benefits of the waters, (2) inefficient use of Federal, State, and local funds in the construction and operation of inadequate facilities, and (3) restrictions on community growth and area development pending adoption of a master plan of severage. We believe that this example demonstrates the need for comprehensive planning if the desired water pollution control objectives and potential benefits are to be attained.

The pictures on the next page show a section of this river and a tributary.

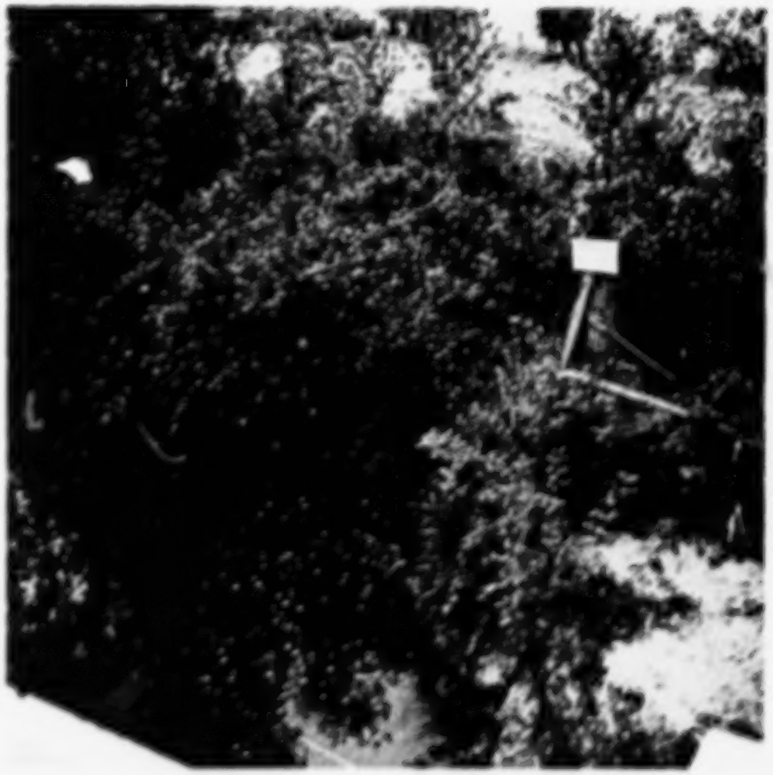

Figure 6

Figure 6 shows a section of a tributary which flows into the river. The sign, posted by the County Health Department, reads DANGER KEEP OUT—CONTAMINATED WATER. The odor emitted by the tributary is generally quite prominent and obnoxious to residents living in homes situated on both sides of the tributary in close proximity to the above area.

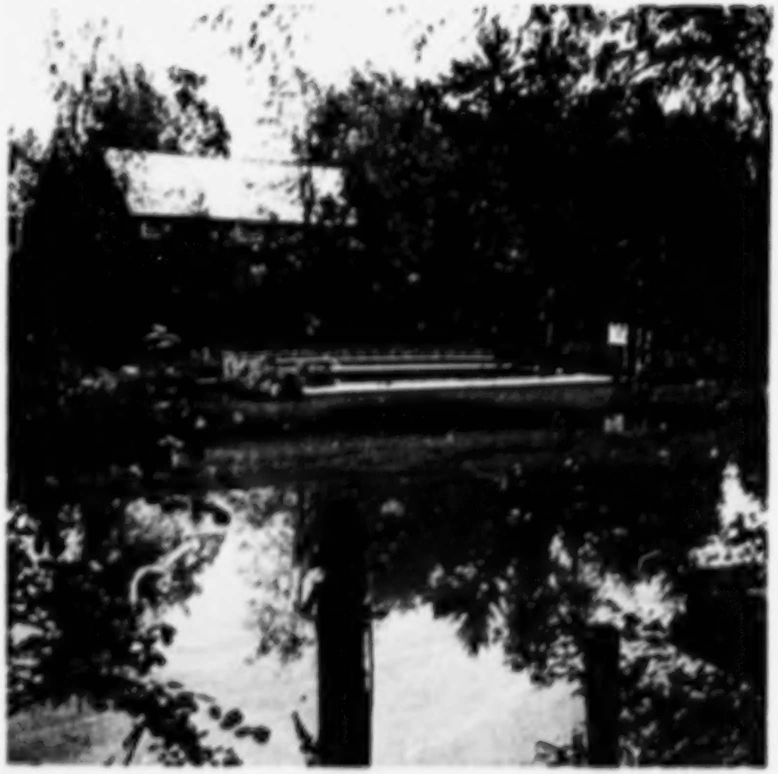

Figure 7

Figure 7 shows a section of the river as it passes a public park. Because of pollution the boat dock and the boarded-off section for swimming are now closed and water contact sports are prohibited. The green color of the river is due to algae and slime growths.

EXAMPLE 3

A river that flows along the boundary of two States has been the subject of two enforcement conferences--one held in 1963 and another in 1968. A 1962 survey prepared for the first conference stated that two industries--a paper company and a chemical and forest products company--were the major sources of BOD in the southern reach of the river. The survey stated also that these industries, together with two municipalities, were the major sources of coliform bacteria.[1]

The conference concluded that industrial and municipal discharges from these sources damaged legitimate water uses by interfering with the propagation of fish and other aquatic life, recreational uses, and water contact sports--uses for which the river was subsequently classified by both States. The conference recommended that specific remedial action be taken by the two municipalities and the two industries.

Two Federal grants totaling $640,000 were awarded to the two municipalities. The first grant, awarded in 1960, was for a primary treatment plant to serve two thirds of the population of the municipality located upstream. A subsequent grant to the municipality located downstream was awarded in 1964 for a secondary treatment plant.

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[1] The amount of coliform bacteria contained in a waterway is significant in determining whether the waterway is acceptable for bathing and other water-contact sports. In addition, shellfish are also adversely affected by certain bacteria. The coliform count is used as an indicator of the quantity of possible disease-carrying bacteria present in the water. Domestic wastes are the primary source of such bacteria. The reliability of this method as an indicator has been challenged at times because the coliform group includes types of bacteria which may not be disease carrying. Since waste treatment for the removal of solids and BOD does not reduce the coliform count sufficiently, chlorination of the treated waste water usually accomplishes the necessary reduction.

The upstream treatment plant removes about 4,500 PE of BOD; however, the paper company located in the same area is discharging more than 400,000 PE of BOD. The downstream municipal treatment plant is removing about 8,000 PE of BOD; however, the chemical and forest products company in that area is discharging about 125,000 PE of BOD.

Some actions were subsequently taken by the two industries to abate water pollution. However, of the four waste sources, only the downstream municipality has complied with the recommendations of the 1963 enforcement conference. Available data indicates that one industry was discharging a greater amount of BOD in 1965 and 1966 than in 1962. The upstream municipality, which had a primary treatment plant that served two thirds of its population at the time of the 1963 enforcement conference, has not provided treatment for the remaining one third, nor has it approved the construction of a secondary treatment plant. As a result of the discharge of raw sewage, without chlorination, from one third of the municipality's population, the coliform bacteria count, which is a frequently used indicator of the quantity of possible disease-bearing bacteria has remained high.

In reference to the upstream location, an FWPCA memorandum dated July 24, 1968, states that:

> "The present condition of the river *** precludes uses for water contact sports and is in a borderline condition during the summer as far as fish survival and propagation are concerned."

With regard to the downstream location, the memorandum states that:

> "Quality of the river precludes water contact and presents a hazard for fish survival and propagation. This area has a history of fish kills."

We believe that the construction of the facilities financed in part with the two Federal grants totaling $640,000 has not appreciably improved the condition of the water nor provided additional uses of the water. Furthermore, it appears that the water quality will not be significantly improved until the two industries that contribute the major portion of the waste load provide adequate treatment of their wastes and the upstream municipality provides treatment and chlorination for the remaining one third of its domestic wastes.

The pictures on the next page show the polluted condition of a segment of the river and two of its tributaries.

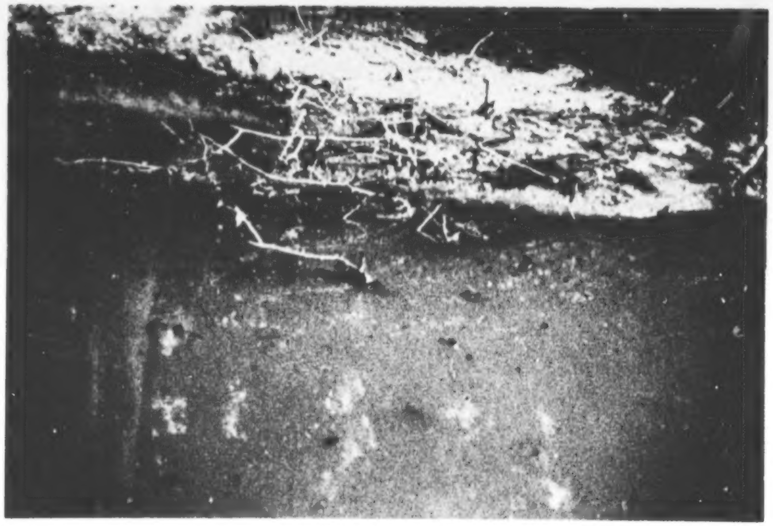

Figure 8

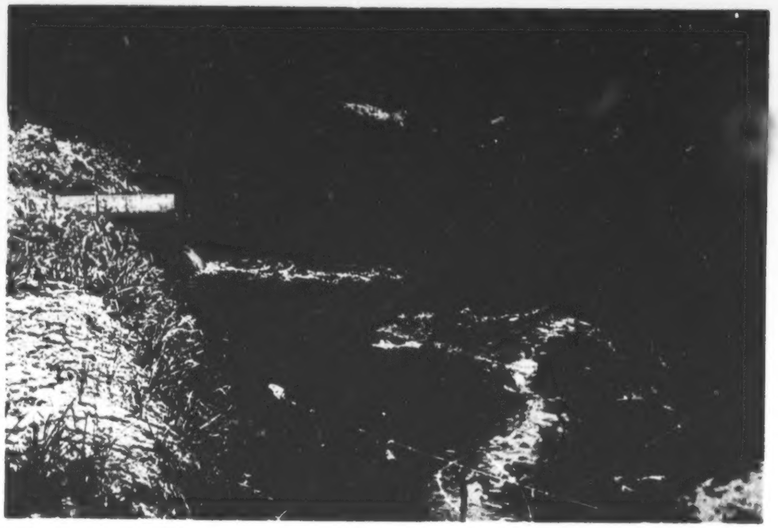

Figure 9

Figure 10

Figure 8 shows a tributary just before it enters the mainstream of an interstate river. The heavily polluted condition of this tributary is indicated by the floating solids, accumulated sludge mats, and discoloration of the river bank. A strong odor is emitted when the sludge mats are stirred up. An industry is the only polluter along this tributary.

Figure 9 shows the discharge of raw domestic sewage to another tributary of the same river. The tributary in the area of the municipal discharge was already in a heavily polluted condition due to industrial waste discharged upstream. Accumulated sludge and debris are seen in the river and along its banks.

Figure 10 shows the interstate river downstream from where the two tributaries enter the mainstream of the river. The bubbles rising to the surface are due to the decomposition of accumulated sludge on the river bottom. As the sludge decomposes and fills with gasses, sludge mats rise to the surface and flow downstream.

EXAMPLE 4

An entire river basin located in one State serves, in one way or another, more than two thirds of that State's population. Since 1956, more than 75 percent of the construction grant funds provided to the State by FWPCA, or about $10 million, have been expended for the construction of waste treatment facilities in this basin.

According to an FWPCA report issued in 1967, 75 percent of the wastes generated in the basin were from the pulp and paper industry, 14 percent from the food-processing industry, 7 percent from municipal sources, and the remaining 4 percent from miscellaneous industrial and municipal sources. FWPCA stated that one of the most serious water pollution problems in that area of the United States, in terms of the impact on the use and volume of water affected, occurred in the lower stretch of the major river in this basin.

The report stated that two pulp and paper mills located at the head of this stretch of the river generated about one third of the wastes of the entire river basin, in terms of PE of BOD. Most of the time the two mills accounted for about 99 percent of the waste load in this stretch of the river. During periods of low flow, particularly during the summer, one mill has transported by barge a large part of its wastes to another waterway where they have been discharged into the water without treatment. The second mill has stored a large part of its waste in a holding lagoon and released the wastes as the flow of the river increased. Notwithstanding these actions, the two mills accounted for about 95 percent of the total wastes discharged into that stretch of the river during low-flow periods.

Prior to establishment of the construction grant program in 1956, municipalities located in the lower stretch of this river that discharged wastes into the river had constructed at least primary waste treatment facilities with chlorination of the effluent. In 1960, however, the State cited the lower stretch of the river as unfit for certain beneficial uses due to low dissolved oxygen and high coliform bacteria concentrations. As a result of public hearings, the State directed four cities in the lower stretch, with a total population of about 30,000, to complete secondary treatment facilities by June 1962. Federal grants totaling about $465,000 were approved and the facilities which cost about $2.1 million were completed in 1963 and 1964.

We estimate that the reduction in BOD after these four municipalities constructed secondary treatment plants approximates 20,000 PE of BOD. When compared with the more than 500,000 PE of BOD discharged untreated by the two pulp and paper mills during low flows and the 2 million PE of BOD discharged by the mills during normal flows, the construction of the four secondary treatment plants has been of little significance in terms of reducing the total BOD.

In a 1967 report, FWPCA stated that floating and suspended solids and unsightly and foul-smelling rafts destroyed the aesthetic beauty of the river and that oxygen levels in the lower stretch, from June through September, block, or at best inhibit, the passage of salmon species. The report stated also that, throughout this stretch, there was only limited water-contact recreation and that public beaches had been closed because bacteria posed a threat to public health.

The State, in a 1968 report on the high bacterial count, stated that:

> "*** the coliform counts on the river have remained higher than expected considering the degree of treatment which is currently practiced by municipal systems. *** Other sources, then, must be principally responsible for the high counts."

The report stated further that the dissolved oxygen level was improved by flows provided through river regulation from dams and impoundments in the upper reaches.

In 1967, the two mills installed primary treatment facilities. According to State officials, this treatment improved the river aesthetically. However, neither the State nor FWPCA officials could provide us with information concerning the extent to which such treatment had reduced the

BOD. In 1968, one mill discontinued its pulp-producing process. The second mill is presently in the process of installing chemical recovery facilities and is expected to install secondary treatment for all its wastes by 1972.

Although these actions should substantially reduce the pollution in this section of the waterway, we believe that municipalities, especially when they are minor sources of pollution, should not be required to construct or upgrade, operate, and maintain treatment facilities long before major industrial polluters on the same waterway are required to construct waste treatment facilities.

EXAMPLE 5

This example involves a 170-mile section of one of the largest interstate rivers in the United States. Although there are more than 20 municipalities located on this stretch, only six discharge their wastes into the river. Two large municipalities account for more than 90 percent of the total population of these six municipalities. In addition to the municipal waste discharges, approximately 80 industrial plants, including 49 oil refineries and chemical plants and nine sugar refineries, discharge their wastes into this section of the river.

This river is used as a water supply by some municipalities and by about 60 percent of the State's water-using industries. It is also used for limited noncontact recreation, for propagation of aquatic life, and as a conveyor of domestic and industrial wastes. The State's water quality standards plan provides for increased usage of the river for essentially these same purposes.

The State conducts a monitoring program that includes a permit system for industrial waste discharges as well as a river-sampling program. The sampling program is particularly concerned with testing for the discharge of toxic and other wastes that may interfere with existing water uses. A State official has informed us that he is not concerned with BOD in connection with this river as long as the dissolved oxygen remains high. According to this official, the flow of the river is such that it has a large assimilative capability to receive waste discharges without adversely affecting existing water uses.

The population of the six municipalities cited above increased from about 730,000 in 1957 to about 1,032,000 in 1968. Sixteen FWPCA grants totaling about $6.1 million and two Accelerated Public Works (APW) grants totaling about $1.6 million were made to five of the six municipalities between April 1957 and April 1969 for the construction of waste treatment facilities. The facilities are to treat the wastes of the total population of three of the municipalities and part of the wastes of two of the municipalities. The sixth municipality has no treatment of its wastes. Treatment facilities that have been completed have reduced the 1,032,000 PE of BOD to about 885,000 PE, or a reduction of about 147,000. Facilities not yet completed are expected to reduce the BOD by another 64,000 PE. However, the untreated wastes of about 525,000 persons from three municipalities will continue to be discharged into the river.

Our examination of the permit files applicable to the 80 industrial plants known to be discharging wastes into this section of the river showed that many did not contain information on BOD, volume of wastes, or suspended solids discharged into the river. For example, we found that information on BOD was contained in the permit files for only 30 plants and information on the volume of wastes was contained in the files for 52 plants. However, for 22 of the 52 plants, the files did not contain sufficient information for us to ascertain the nature and volume of the wastes which were permitted to be discharged into the river. We were advised by a State official that many of the permits did not contain information on BOD because either the (1) types of wastes involved did not contain BOD or (2) BOD effects of the wastes were not known. However, the data on BOD that was available showed that the BOD contained in the wastes, which were permitted to be discharged into the river, increased from about 970,000 PE in 1957 to about 3,383,000 in 1967.

Although the data is incomplete, it shows a substantial increase in the industrial wastes permitted to be discharged into the river since 1957. During this period, the BOD contained in industrial wastes permitted to be discharged into the river increased by about 2.4 million PE of BOD, while the increase in BOD resulting from population growth amounted to about 300,000 PE.

The reduction in municipal BOD that has been accomplished (147,000 PE) is of little consequence when compared with the increase in BOD permitted to be discharged by industries (2.4 million PE). In addition, the raw wastes of about 525,000 persons will continue to be discharged into the river, even after projects in progress are completed. Thus, the construction of waste treatment facilities with the aid of $7.7 million in Federal grants has not had an appreciable effect in abating, controlling, and preventing water pollution on this section of the river.

EXAMPLE 6

The major sources of pollution on one section of a river are domestic and industrial waste discharges from two municipalities located across from each other about 10 miles from where the river meets the ocean. The primary use established by the State for this section of the river from 1957 to 1967 was the transportation of municipal and industrial wastes without creating a nuisance.

An FWPCA grant of $27,000 was made to municipality A in 1961 to aid in the construction of a primary treatment facility to serve only part of the municipality's population. Municipality B received an FWPCA grant of $456,000 in May 1963 and an APW grant of $324,000 6 months later, or a total of $780,000 in Federal funds, to aid in constructing a secondary treatment facility. Municipality B's plant has been in operation since 1965. On the basis of data contained primarily in a 1967 FWPCA report, we estimate that the two treatment facilities decreased the total BOD in the river by about 10 percent.

A tannery located in municipality A and a textile plant located in municipality B, however, accounted for about 82 percent of the total BOD (74 percent and 8 percent, respectively). These plants discharge untreated wastes directly into the waterway. In addition, the domestic wastes from a sewered population of about 4,500 in municipality A (which represented about 4 percent of the total BOD) were being discharged, without treatment, into the waterway.

In its 1967 report, FWPCA stated that untreated domestic wastes at municipality A and untreated industrial wastes at municipalities A and B produced obnoxious sludge banks, heavy scums, sludge mats, and high bacterial loadings from their entry point to the ocean. Thus, Federal funds in excess of $800,000 have been expended for the construction of waste treatment facilities, which have not appreciably reduced the polluted condition of the waterway.

The State's water quality standards plan of 1967 proposed a classification for the waterway that would permit its use for such purposes as recreational boating, fishing, and a fish and wildlife habitat. Industry has generally been given until 1976 to complete construction of the facilities required to meet the goals established in the State's 1967 water quality standards plan. The State's implementation plan in 1967 provided for municipality A to complete a facility during 1969 at an estimated cost of $1.7 million. In 1969, the estimated costs were increased to about $2.4 million. State officials advised us that the primary reason for the increase in costs resulted from the municipality's revised plan to construct two municipally owned waste treatment plants, one that will treat the domestic wastes and the other that will treat the tannery's wastes--both to be completed by 1971. The primary treatment facility constructed with the aid of the 1961 grant will be replaced by an interceptor sewer to transport the wastes to the proposed treatment plant.

EXAMPLE 7

This river flows primarily within one State before entering a second State, where it flows for 4 miles before merging into a larger interstate river. The condition of the river has not changed since 1956. At its headwaters it is suitable for bathing, water-contact sports, excellent fish and wildlife habitat, and agricultural and certain industrial process uses and is acceptable for public water supply when appropriately treated. Within a short distance from its headwaters, the condition of the river is such that bathing and water-contact sports are not permitted and the water is less suitable for the other uses mentioned above. About midway between its headwaters and mouth, the river's condition deteriorates so that it is suitable primarily for industrial uses.

Organic wastes from domestic and industrial sources accounted for approximately 54,000 PE of BOD, of which industry contributed about 30,000 PE. Two municipalities that contributed domestic wastes constructed secondary treatment facilities with the aid of FWPCA grants of about $260,000 and an APW grant of about $180,000 awarded between 1959 and 1962. The treatment of domestic wastes discharged into the river by these two municipalities reduced the BOD from about 24,000 PE to about 3,000 PE.

Although this treatment has substantially reduced the BOD resulting from domestic wastes, the continued discharge of about 30,000 PE by industries contributes to the deteriorated condition of the lower half of the river. In addition to the industrial PE of BOD, inorganic wastes are being discharged into the river by about 35 metal-plating plants. Although most of the plants are quite small, FWPCA reports indicate that in total they handle large volumes of a variety of highly toxic chemicals. Of these, the cyanides of various metals used in plating are toxic to aquatic life, even in low concentrations.

FWPCA enforcement conferences concerning this river were held in January 1965 and in May 1968. The latter conference indicated that about half of the industries located on the river were behind schedule in providing the necessary facilities to adequately treat their wastes. A State official informed us that he believed the problem of industries to be a technical one, in that the toxic wastes could not be treated in the municipal facilities because of their harmful effects on the biological process in secondary treatment. With regard to the construction of waste treatment facilities, the following table shows the status, as of June 1969, of 37 industries that are listed in the State's water quality standards implementation schedule.

Construction started	8
Construction not started	22
Discharging to municipal system	2
Out of business	2
Moved to another State	1
No longer a source of pollution	1
Unknown	1
Total	37

Federal grants of about $440,000 were made between 1959 and 1962 to assist in the construction of waste treatment facilities at the two major municipalities located on the river. These waste treatment facilities significantly reduced the extent of BOD emanating from domestic sources in these municipalities. However, the reduction in BOD did not appreciably improve the water quality because the industries located on the river had not provided adequate treatment for their wastes. Until such time as the industries adequately treat their wastes, much of the river can be expected to remain in a polluted condition.

EXAMPLE 8

A stream flowing from one State into Canada was classified by that State in 1955 as suitable for bathing, recreation, fish habitat, and water supply. On the basis of this classification, the State, in 1960, instituted legal action against municipality A, which had a population of 900, to require treatment of the domestic wastes being discharged into the stream. The municipality received an FWPCA grant of $73,000 in late 1962 and an APW grant of $32,000 in early 1963 to assist in constructing a primary waste treatment facility. The construction of the facility was completed and the facility was placed in operation in 1964. As a result, the BOD being discharged into the stream was reduced from 900 PE to 600 PE and there was a reduction in the coliform bacteria.

At least a year before the Federal grants were awarded to municipality A, a food-processing plant went into operation in municipality B which is located upstream from municipality A. Fish kills and nuisance conditions were reported in the spring and summer of 1962 and again in 1963. The State, in 1963, ordered the company to abate its pollution by August 1964.

In January 1964, the Area Redevelopment Administration (ARA) authorized a $6.9 million loan for the construction of another food-processing plant in municipality B. In June 1964, the ARA authorized a $1 million loan to expand the first processing plant, as well as to improve waste treatment. The company installed waste treatment facilities which were not approved by the State.

Tests of the stream quality in 1965 showed little improvement. To accommodate the second food-processing plant, the State lowered the stream's classification in 1965, designating the stream as suitable primarily for the transportation of sewage and industrial wastes without creating a nuisance. ARA and Economic Development Administration loans totaling $2.8 million were authorized in 1965 and 1966 for expansion of the two food-processing plants at municipality B. Tests in 1965, and again in 1966, showed violation of the stream's classification and the existence of nuisance conditions in the stream. In 1966, the first company received a demonstration grant of $196,000 from FWPCA to study the problem of waste treatment at the food-processing plants.

The magnitude of the food-processing wastes and the relative insignificance of the wastes of municipality A, in terms of PE of BOD, are illustrated by data contained in a 1967 FWPCA report. According to that report, the combined PE of BOD from the food-processing plants amounted to between 164,000 and 234,000 and the total PE of BOD from municipality A amounted to about 900. The operation of the primary treatment facility at municipality A reduced the PE of BOD from 900 to about 600.

In its water quality standards plan of 1967, the State proposed that the stream be made suitable for recreation, boating, irrigation, and a fish and wildlife habitat. In its 1967 report, however, FWPCA described the condition of the stream as unsatisfactory, with nuisance conditions occurring during periods of low flow. A State document described the stream in 1967 as grossly polluted and a nuisance, dissolved oxygen being depleted in midwinter. In its 1967 plan, the State scheduled the food-processing plants to complete construction of their waste treatment facilities in 1971, and scheduled the upgrading of municipality A's waste treatment facility to secondary treatment by 1975.

However, in the fall of 1968, the food-processing plants began holding the combined wastes in a lagoon and spraying the wastes into fields. During the winter this measure resulted in the creation of huge ice configurations from the frozen spray. In February 1969, the lagoon dike ruptured and severely polluted the stream. In March 1969, the wastes were being sprayed into a swamp, but they overflowed into the stream and again caused significant pollution. A State official said that, if it had not been for a slow thaw in the spring of 1969, additional wastes would have run off into the stream.

The State official expressed the belief that the same condition could be expected to occur next winter and spring unless additional action is taken by the plants. He stated that he was not aware of any plans for additional action. He stated also that the State had a nuisance complaint in the courts, but he expected that a motion to discontinue the action would be successful since the plants employed a large number of people in the area.

We were informed by this official that treatment facilities were no longer planned for the food-processing plants. He said that the industrial waste loads had increased far beyond the permit loads, to the extent that 90-percent removal of BOD would not permit the stream to assimilate the effluent.

Thus, even though fish kills and nuisance conditions occurred in early 1962 from the operation of a food-processing plant upstream, Federal grants totaling $105,000 were awarded to municipality A for the construction of a primary waste treatment facility. The subsequent expansion of industrial development in municipality B, with Federal assistance, between 1964 and 1966 has served to aggravate an already undesirable pollution problem. As a result, the operation of the treatment plant at municipality A since 1964 has not resulted in improvement of the water quality, nor has it prevented nuisance conditions from occurring in the stream.

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Our examination has shown that FWPCA and the States have not adequately coordinated the planning and the construction of municipal waste treatment facilities with that of other major polluters on a waterway or section of a waterway. Rather, the construction of municipal waste treatment facilities appears to have been administered without sufficient regard to what was being planned or done by other municipalities and industries. As a result, significant amounts of Federal, State, and local funds have been expended for the construction of waste treatment facilities which, in many cases, have not resulted in attaining the maximum benefits in terms of improved water quality because major polluters--industrial or municipal--located nearby continued to discharge untreated or inadequately treated wastes into the waterways.

In addition to the fact that many municipalities have constructed treatment facilities without obtaining the benefits of significantly improved water quality or uses, these municipalities have incurred annual expenses for the operation and maintenance of the facilities. We recognize that all polluters should adequately treat wastes to accomplish the States' water quality objectives. In view of the magnitude of the water pollution problem, however, it may be many years before the construction program is completed. Thus, we believe that interim goals or objectives should be established, whereby significant improvement in water quality and uses can be attained on some waterways or sections of waterways each year.

Our review has shown that the construction of municipal waste treatment facilities primarily on the basis of readiness and willingness to proceed has not, in many cases, accomplished water quality improvement objectives, and our examples demonstrate that municipalities that incur the expenses of constructing, operating, and maintaining waste treatment plants are not always realizing the benefits anticipated as a result of the construction. A more effective approach, in our opinion, would require a coordinated and systematic effort on the part of all polluters along a waterway to construct waste treatment facilities over a specified period of time.

CHAPTER 5

FACTORS LIMITING THE ATTAINMENT OF WATER IMPROVEMENT OBJECTIVES

The attainment of water improvement objectives depends to a large extent on the consideration and solution of a number of problems. We believe that consideration and resolution of the problems described in the following paragraphs is necessary to develop a coordinated and systematic program to achieve desired improvements in water quality in a more effective and efficient manner.

POLLUTION FROM COMBINED STORM AND SANITARY SEWERS AND INFILTRATION OF SEWERS

Combined storm and sanitary sewers carry domestic wastes of a municipality as well as storm runoff, and infiltration of sewers results when sewers crack or break and permit storm and/or ground water to enter the system. Both of these situations create pollution problems. High flows in these sewers during storms may result in untreated or inadequately treated sewage's being discharged into a waterway.

The concern over pollution from combined storm and sanitary sewers and infiltration of sewers usually arises in situations where municipalities are already treating their sewage. The normal flows in combined sewers are relatively low and slow moving, which permit a buildup of solids in the sewer system. During storms, the high flow and fast movement create a flushing effect that washes the buildup of solids out of the sewer system.

Treatment plants usually provide some excess capacity but are not designed to handle the increased flows of waste water that can occur during a storm. Treatment of wastes takes time. The primary process involves holding the wastes to permit floating solids to be removed and settleable solids to collect on the bottom. The resultant effluent then may go through a chlorination process before discharge. Secondary treatment provides biological treatment of the primary effluent. The biological process may require several hours, depending upon the design of the process.

When sewer flows are in excess of the capacity of the treatment plant, the municipality is faced with several alternatives. One alternative is to provide adequate treatment for as much of the flow as possible and to discharge the untreated excess flow into the waterway. Another is to compromise the effectiveness of the treatment plant by providing some treatment to as much of the flow as possible. In such situations, the biological process included in secondary treatment is often ineffective.

Since the flow from combined sewers contains a mixture of storm runoff, domestic sewage, and possibly industrial wastes, the excess flow may be discharged into a waterway by overflowing or bypassing the treatment plant and, as a result, large quantities of solids and coliform bacteria may go directly into the waterway.

Two of the methods that have been proposed as solutions to the pollution problem caused by combined storm and sanitary sewers are:

1. Construction of separate collection systems for sewage and continued use of the existing sewers for storm water.

2. Construction of holding basins at the end of each combined sewer to retain the overflows and, as plant capacity permits, pumping of the overflow to a waste treatment plant for treatment before discharge in to a waterway.

The solution to this problem appears to be the finding of an economical way to handle the overflow. The solution of separating the combined-sewer systems is considered impracticable in many cases. The cost of constructing separate sewers, for the most part, would not be eligible for construction grants because these sewers are primarily collecting sewers. The cost of constructing holding basins for the overflow until a storm subsides and then providing adequate treatment as plant capacity permits would probably be eligible for construction grants. The magnitude of these costs, however, is illustrated by one metropolitan area's estimate of about $500 million to solve its combined-sewer problem. An FWPCA official stated that, although construction grants might be used to a limited extent, the grant program was not intended to finance the substantial costs associated with solving the combined-sewer problem.

A study of the Merrimack River made by CDM (see pp. 83 and 84) showed that the problem of combined sewers was significant and should be considered in planning for water pollution control and abatement. CDM stated in its report that combined-sewer overflows, upstream from secondary or tertiary treatment plants, result in defeating the purpose of secondary or tertiary treatment to protect the river for such uses as water-contact sports. CDM expressed the opinion that water quality, suitable for bathing and other water-contact sports, could be protected only when all upstream sewage discharges, including combined-sewer overflows, receive adequate disinfection prior to discharge. CDM estimated that it would cost about $140 million to solve the combined-sewer problems of six medium-sized municipalities on the Merrimack River whose populations ranged from 30,000 to 150,000.

According to an official in one State, some of the money now being used for constructing secondary treatment facilities would be more appropriately used in solving the combined-sewer problem. The water quality standards of one State are not applicable during periods of storm runoff because of the combined-sewer problem. This State, however, requires that wastes discharged into all inland waters receive secondary treatment.

We believe therefore that a meaningful plan for control of water pollution should consider the solution to the combined-sewer problem, including the manner and timing of the required financing.

FUNDING FOR WATER POLLUTION CONTROL

Prior to 1967, the construction grant program provided incentives primarily to small municipalities in that the dollar limitations contained in the act represented a meaningful contribution to the costs of constructing small waste treatment facilities but did not provide a real incentive to the large municipalities. We believe that such limitations did not encourage the construction of municipal waste treatment facilities capable of treating substantial quantities of industrial wastes.

The following table shows, by population of the municipalities, the number of waste treatment projects for which Federal construction grants were made through June 30, 1969, and the amount of the grants.

Population	Number of projects	Percent of projects (cumulative)	Federal grants	Percent of grants (cumulative)
Less than 2,500	4,641	49	$ 224,368,484	17
2,500 to 5,000	1,359	64	156,956,004	28
5,001 to 10,000	1,158	76	187,349,738	42
10,001 to 25,000	1,045	87	254,855,555	61
25,001 to 50,000	518	92	175,688,014	74
50,001 to 125,000	334	96	163,926,363	86
125,001 to 250,000	155	98	73,773,793	92
250,001 to 500,000	87	98	36,913,087	95
Over 500,000	148	100	71,025,224	100
	9,445[a]		$1,344,856,262[b]	

[a] Estimated total cost of the 9,445 projects is $5,351,572,735.

[b] Includes grants from FWPCA and other Federal agencies.

The table shows

--that 49 percent of the projects were in municipalities having populations of less than 2,500 and that 17 percent of the Federal grants were to these municipalities and

--that 92 percent of the projects were in municipalities having populations of 50,000 or less and that

74 percent of the Federal grants were to these municipalities.

A number of State officials informed us that insufficient Federal funds was a problem, and was expected to continue to be a problem, in carrying out the construction set forth in the water quality standards implementation schedules. They stated that, prior to 1967, Federal funds were usually sufficient to finance the projects for which applications were submitted. In our opinion, this may have been primarily due to the dollar limitations on Federal grants for individual projects, which did not provide a sufficient incentive for the larger municipalities to construct waste treatment facilities or large, joint municipal-industrial waste treatment facilities. If the dollar limitations for individual projects had been higher earlier in the program, it is possible that Federal funds prior to 1967 also would have been insufficient.

Through June 30, 1969, Federal construction grants averaged $142,400. Since the elimination of the dollar limitations in 1967, many of the larger municipalities have applied for construction grants, and there has been a growing trend to construct joint municipal-industrial waste treatment facilities. We found that as of June 30, 1969, there were applications pending at the FWPCA, State, or local levels for construction grant funds totaling in excess of $2.3 billion for 4,648 projects having an estimated total construction cost of about $5 billion. The average grant pending is $495,000, or 3.5 times the average amount of the grants awarded through June 30, 1969.

Thus the problem of financing waste treatment facilities continues to mount, in our opinion, because (1) during a time of increasing costs, municipalities are relying on the Federal Government to share in the cost of constructing facilities, (2) the elimination of the dollar limitations has provided the incentive for many large municipalities that need multi-million-dollar treatment plants to participate in the construction grant program, which places greater demands on Federal funds, and (3) appropriations far below authorizations in fiscal years 1968 and 1969 have precluded many municipalities from receiving Federal funds and few are proceeding without Federal and/or State financing.

Furthermore, the extent of the potential demand on Federal funds is difficult to assess, because many cost estimates either are not available or are incomplete. (See pp. 75 to 77.)

Effect of Federal funding on completing construction set forth in the water quality standards implementation schedules

Our review showed that the rate of construction in the States was significantly influenced by the level of Federal appropriations. Since appropriations have been far below the amounts authorized in fiscal years 1968 and 1969, the progress of many States in carrying out the construction set forth in their water quality standards implementation schedules has been adversely affected.

On the basis of the fiscal year 1969 allocations of Federal grant funds to selected States and the States' estimated costs of carrying out their construction programs, we projected the number of years that it would take to complete the construction programs. We assumed that construction would continue to proceed at a rate consistent with Federal appropriations, and we did not consider the cost of solving the combined-sewer problem.

One State, which established a 9-year construction program, estimated that, on the basis of current levels of authorized FWPCA participation, the implementation of the program would require FWPCA grant funds of about $60 million. On the basis of the 1969 allocation of $1.9 million of Federal grant funds to this State, about 30 years will be required to complete the State's program. If this State is to complete its construction program in 9 years, an FWPCA annual allocation of grant funds of about $6.7 million, or 3-1/2 times greater than the 1969 allocation to the State, would be required.

A second State, with a 10-year construction program, would be eligible to receive about $55 million in FWPCA grant funds. On the basis of its 1969 allocation of grant funds of $1.4 million, it will take the State about 40 years to complete its construction program. If this State is to complete its program within the 10-year period, an FWPCA annual allocation of grant funds of about $5.5 million would be required.

A third State, which established a 5-year construction program, would be eligible to receive about $117 million in FWPCA grant funds. On the basis of its 1969 allocation of grant funds of $5.3 million, it will take this State about 20 years to complete its construction program. To complete its program within the 5-year period, the State would have to receive FWPCA grants of about $23 million each year.

These examples illustrate the disparity that exists between the Federal funds appropriated and allocated to the States in recent years and the potential Federal share of the waste treatment plant construction costs that will be required over the next several years. On the assumption that the State construction programs will continue at rates consistent with the availability of Federal funds, it is apparent that significant increases in FWPCA construction grant fund appropriations will be required if the States are to meet the 5 to 10 year construction schedules established in their water quality standards implementation schedules.

Several bills have been introduced in the Ninety-first Congress that propose a method of financing to supplement the FWPCA funds for grants to municipalities for the construction of waste treatment facilities. Under the proposed method, the Federal Government would enter into contracts with municipalities that would provide for payment by the Federal Government of its share of the construction cost of certain waste treatment facilities over a period not to exceed 30 years. The bills provide that the total sum available for such financing in fiscal years 1970 and 1971 not exceed the sum authorized to be appropriated for direct grants, less the sum appropriated for direct grants.

Cost estimates for constructing waste treatment facilities

In 1967 many of the States developed estimates of the cost of constructing planned municipal waste treatment facilities. One State official referred to his State's estimate as "very rough." Officials of another State, which had developed its implementation schedule on the basis of its 1967 construction cost estimates, stated that the State would not be able to provide a current estimate of the costs of municipal waste treatment facilities until such time as the preliminary engineering studies were received.

A third State estimated in 1967 that its costs for constructing municipal waste treatment facilities would amount to about $120 million. This estimate was increased to about $145 million in 1968, even though eight projects included in the 1967 estimate were not included in the 1968 estimate. One project cost estimate, for example, was increased from $1.4 million in 1967 to about $4.4 million in 1968, primarily because the 1968 estimate included the costs required to treat wastes from a papermill, which costs were not included in the 1967 estimate.

None of the States which we visited had developed separate estimates of the costs of constructing municipal waste treatment facilities for treating both domestic wastes and significant volumes of industrial wastes. The estimated cost of constructing facilities for the treatment of industrial wastes were presumably included, to the extent known, in the figure cited for the municipalities. In one State, for example, the officials stated that all but one industry would be using municipal waste treatment facilities.

Three of the States that we visited had 1967 estimates of the costs of constructing industrial waste treatment facilities. Officials of one State labeled the estimate as "very rough". Officials of another State in 1967 estimated such costs at $107 million, but in 1968 they increased the estimate to $130 million. None of the six States included in our review that are affected by combined sewer overflows or infiltration of sewer lines was able to estimate the costs required to resolve these problems.

Current estimates of costs for the matters discussed above are important. Unless realistic estimates are available, the demand on the construction grant program funds cannot be anticipated or planned for on a realistic basis. For example, if the trend toward municipal or State treatment of industrial wastes continues, it may well be that much of the costs of treatment facilities which presently are considered to be industry's responsibility may become eligible for Federal assistance. This factor, together with the multi-billion-dollar cost associated with the combined-sewer problem, may well result in a heavy demand on Federal construction grant funds in the future.

POLITICAL AND INSTITUTIONAL CONSTRAINTS

State officials informed us that one of the basic problems that they had encountered in implementing State water pollution control programs was the difficulty in obtaining agreements from municipalities and water-using industries to proceed with the construction of necessary waste treatment facilities. Even with the Federal construction grant program and some State grant programs, local financing has been, and apparently will continue to be, a problem for many municipalities and industries.

Needed financing arrangements have not been adopted or voted by municipalities for a variety of reasons, including the matter of local priorities. For instance, a municipality may consider school or road construction to be of a higher priority than the construction of a waste treatment facility.

Even though the problem of local financing seems to be one of the primary reasons why many municipalities have not constructed waste treatment facilities, another problem involves the failure to form multimunicipal, regional, and river basin pollution control authorities. In some instances, when attempts have been made to form such authorities, difficulties have been encountered in achieving agreements among the individual governing entities. Example 2 in chapter 4 points out the problems that occurred when one area attempted to solve its waste treatment problems on a regional basis.

Our review showed also that State water pollution control agencies had been handicapped by the lack of qualified personnel needed to effectively administer their programs.

OTHER PROBLEMS WHICH NEED CONSIDERATION

Water pollution control must also deal with such problems as (1) natural pollutants, (2) thermal pollution, and (3) pollutants from runoffs involving urban areas, mines, and agricultural lands, as well as oils and chemicals from industrial operations. Such factors as population growth and industrial expansion, as well as economical and technological solutions to industry's waste treatment problems, will also need to be considered in achieving and protecting high water quality and additional water uses on a broad, national basis.

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The above factors will play an important part in the success in achieving or the failure to achieve the water improvement objectives set forth in the States' water quality standards plans. The problems are difficult and widespread. We believe, however, that Federal, State, and local officials, in formulating water pollution control programs, must find practicable solutions to resolve the problems if effective water pollution control is to be attained.

CHAPTER 6

USE OF SYSTEMS ANALYSIS METHODS IN DETERMINING NEEDS AND IMPLEMENTING PROGRAMS FOR WASTE TREATMENT FACILITIES

As discussed in chapter 3, construction grants for waste treatment facilities continue to be awarded primarily on a readiness-to-proceed basis. This method of awarding grants, together with solutions to the problems discussed in chapter 5, may eventually result in abating and controlling water pollution. We believe, however, that Federal construction grant funds are not being utilized in the most effective manner and that, as a result, the immediate benefits attained from the construction of waste treatment facilities are not as great as they could be.

In view of the limited resources available and the magnitude of the construction program, we believe that there is a need for FWPCA and the States to (1) establish interim objectives or goals, (2) give greater consideration to alternatives, and (3) provide a more systematic approach for establishing priorities and awarding grants for the construction of waste treatment facilities. We believe that the application of systems analysis techniques to water pollution problems may be appropriate.

SYSTEMS ANALYSIS AND WATER POLLUTION CONTROL

Systems analysis may be viewed as the search for, and evaluation of, alternatives which are relevant to define objectives, based on judgment and, whenever useful, on quantitative methods, with the objective of presenting such evaluations to decisionmakers for their consideration. It emphasizes the systems concept under which any course of action designed to achieve an objective is viewed as a system requiring inputs and producing outputs. The inputs and outputs involved may take on any of a large variety of forms. In this sense, systems analysis encompasses both cost-benefit and cost-effectiveness analyses, as well as other types of analysis which may be more limited in scope.

In August 1965, the President directed Federal civilian agencies to install planning, programming, and budgeting (PPB) systems. Two objectives of PPB systems are analyses of:

1. Outputs of a given program in terms of its objectives.

2. Alternatives to find the most effective means of reaching basic program objectives.

The procedures followed by FWPCA in administering the construction grant program and in approving grant requests provide for neither the analysis of the output in relation to the objectives nor the analysis of the effectiveness of various alternatives in reaching the objectives. We believe that a systems analysis approach to water pollution control may provide the necessary data for analyses of this nature. By utilizing systems analysis techniques, the results, in terms of improved water quality, can be projected for a planned waste treatment plant or combination of plants. The use of modern management tools such as systems analysis could provide dynamic means for measuring progress as construction phases are completed. We believe that this management approach will assist responsible officials in meeting the goals of the water pollution control program.

Systems analysis can identify alternatives to be considered by the States in assigning priorities and in scheduling the construction of waste treatment facilities so that remedial actions can be scheduled as early as possible in order to attain significant benefits.

With the use of systems analysis techniques, FWPCA and State officials could also identify the least costly method of attaining water quality objectives. A least-cost solution requires that consideration be given to:

1. The water quality standards and uses of the waters established by the States.

2. The assimilative capacity of waterways, that is, the amount of wastes that can be discharged into a waterway without lowering the water quality, due to the waterway's natural self-purification ability.

3. Alternative levels of waste treatment--generally primary, secondary, and tertiary.

4. The need for a coordinated effort by all polluters-municipal, industrial, and Federal.

FWPCA USE OF SYSTEMS ANALYSIS

FWPCA has, to a limited extent, used systems analysis techniques for water pollution control planning on a river basin basis. The FWPCA analyses have generally considered final objectives in terms of improved water quality but have not considered interim goals or time-phased schedules for the construction of needed waste treatment facilities. FWPCA concentrated on the development of mathematical models associated with the physical environment--the physical cause-effect relationships among waste controls, waste production, hydrology, and stream quality.

A mathematical model, which dealt with the relationship between BOD and the dissolved oxgen in a river, was developed in 1925 by Public Health Service staff members. This model was applied by the Public Health Service in 1925 in a study of pollution in the Ohio River. Modeling techniques were not extensively utilized by FWPCA, however, until the advent of computer technology.

In 1960, the FWPCA Dallas Regional Office developed a model for use in considering the dissolved-solids problem in the southcentral section of the country. Later, FWPCA, in considering the problems of water quality management in estuaries, directed its modeling activities toward the estuarine environment and studied the Delaware Estuary. Models that were developed during the Delaware Estuary Study are being used on the Potomac River and in the New York-New Jersey area.

DEVELOPMENT OF A PRACTICAL SYSTEMS ANALYSIS METHOD BY CDM

The development of a systems analysis method, together with a demonstration of its practicality on an actual waterway, required a technical capability that we did not possess within our Office. Data had to be obtained, analyzed, and evaluated on such matters as the hydrology of the waterway and its assimilative capacity; the sources, types, and quantities of wastes; the minimum level of treatment needed; the location for outfalls; and design and cost data of treatment facilities. Therefore on February 18, 1969, we entered into a contract with CDM, to assist us in this phase of our review.

One objective of the CDM study was to demonstrate the usefulness of systems analysis in the development and implementation of plans for the construction of waste treatment facilities. One authoritative view is that the test of the success of a systems analysis method is not whether it provides the perfect answers but whether it provides better answers than would have been obtained by alternative techniques. For its study, CDM used the Merrimack River which flows through the States of New Hampshire and Massachusetts.

Method developed by CDM

CDM accumulated and evaluated data on the Merrimack River and used a mathematical model and two computer programs to estimate the construction costs of waste treatment facilities for various degrees of water quality. CDM, in making its study, also used certain data contained in the Massachusetts and New Hampshire water quality standards plans for the Merrimack River. The CDM report to GAO (1) identified various alternatives available, such as the least costly method for obtaining various objectives or water uses for the entire river and for individual stretches of the river as established by the States' plans, (2) showed the additional construction costs of enhancing the water quality to the highest practicable level if secondary treatment were required for all wastes and showed the uses of water that could result if all municipalities constructed secondary treatment plants, and (3) showed a phased construction schedule for the Merrimack River predicated on achieving interim benefits as early as possible and at the least cost.

According to CDM, its model is designed to be a dynamic planning device, that is, as water quality data continues to be collected and, as treatment facilities are constructed, the computer programs can be adjusted to recognize changes. This will prevent obsolescence of the method as a planning device and will permit progress to be evaluated more effectively.

The CDM study did not include consideration of all the means that are available for controlling and abating water pollution. The study was limited to those means which are eligible for Federal funds under the construction grant program. For example, CDM did not consider low-flow augmentation and in-stream aeration as alternatives for controlling and abating water pollution because current legislation does not provide FWPCA with the authority to make Federal grants for projects of this nature. The mathematical model and the computer programs developed by CDM include means for considering these alternatives should it become desirable to investigate their feasibility.

The study was also limited to a dissolved-oxygen analysis with consideration given to BOD waste loads. CDM assumed, for the purposes of its study, that, if water-contact sports were included as an objective in the States' water quality standards, all upstream waste discharges would receive at least primary treatment and chlorination of the effluent to substantially reduce the coliform bacteria. The natural die-away of coliform bacteria was not considered by CDM to be a sufficiently dependable process on which to rely for the protection of the public health. Additional types of pollution, such as phosphorous or dissolved salts, although not included in CDM's study, could be considered and evaluated by use of the mathematical model by inserting the pertinent information into the computer program as input data.

Results of the application of the CDM method to a specific waterway

In its report to us on the results of its study of the Merrimack River, CDM showed the benefits that are available from utilizing a systematic approach of this nature in the planning and implementing of water pollution control measures. We have included CDM's summary of its report as appendix I. Some of the more significant matters are discussed below.

Analysis of the States' implementation schedules

In its study CDM considered the States' proposed construction implementation schedules in seven annual increments and, through the use of a mathematical model, estimated the water quality that would result from the completion of each increment of the schedules based on projected 1976 waste loads. CDM considered also alternative construction schedules, two of which are identified as increments VIII and IX. (See p. 27 of app. I.)

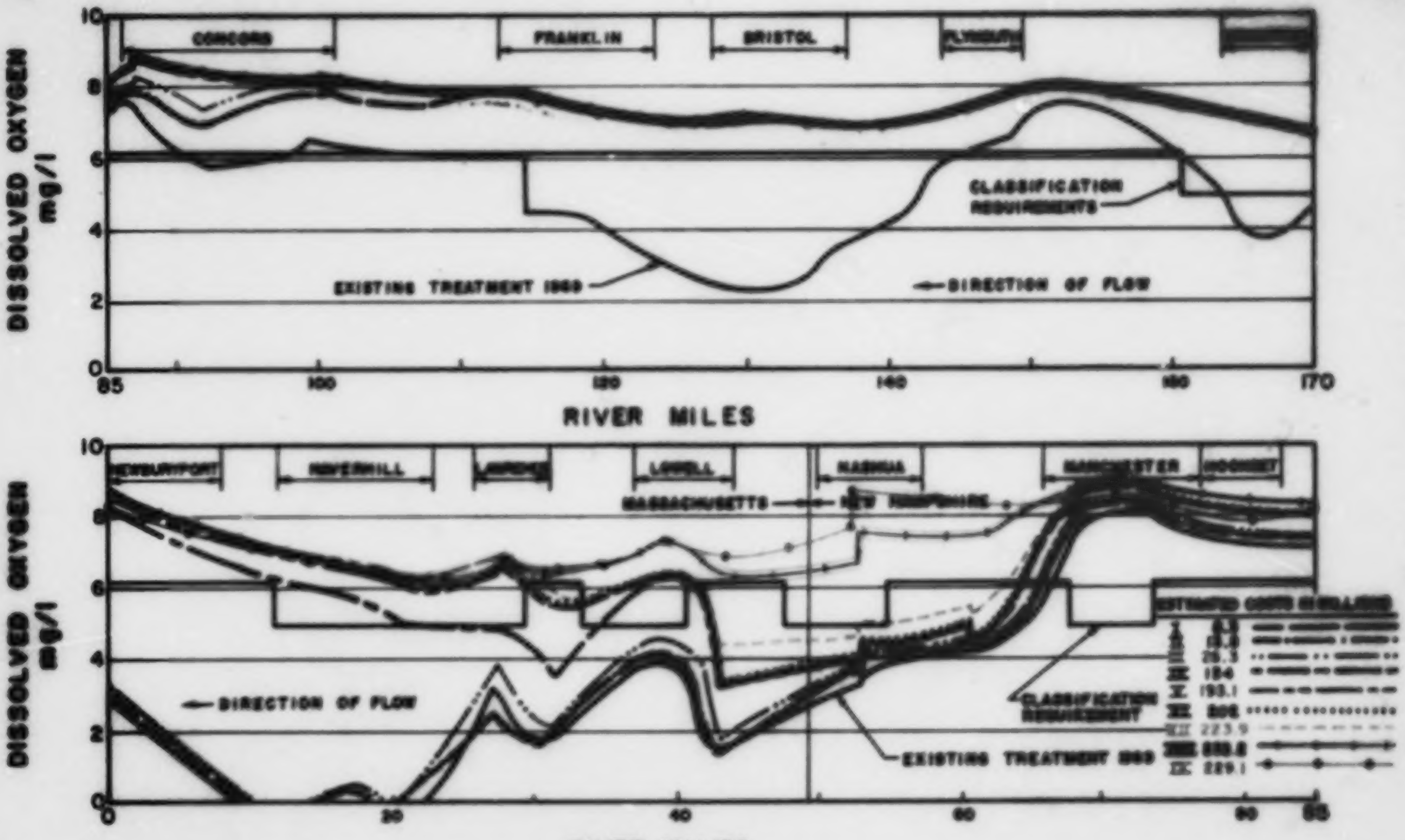
The study showed that, if no additional treatment plants were constructed by 1976, about 25 miles of the river would be in a nuisance condition and about 70 percent of the river, or 120 miles, would be below the States' water quality standards. Completion of the first increment at a cost of $8.3 million would leave the 25 miles still in a nuisance condition and about 40 percent of the river, or 70 miles, would still be below the States' water quality standards. Completion of increments II and III at an additional cost of $20 million would result in little improvement in the quality of the river.

Completion of increment IV at an additional cost of $125.7 million would eliminate the nuisance conditions in the river, but 26 percent of the river would still be below the States' water quality standards. The completion of increments V and VI at an additional cost of $48 million would not appreciably improve the water quality. Completion of increment VII would cost an additional $21.9 million.

The completion of the Massachusetts and New Hampshire proposed construction implementation schedules (increment VII) at a total cost of about $224 million would still leave about 10 percent of the Merrimack River below the water quality standards established by the States.

CDM developed two alternative implementation schedules that would result in the attainment of the States' water quality standards for the Merrimack River. The first alternative, shown as increment VIII, would be the construction of secondary treatment plants at all municipalities along the Merrimack at an estimated cost of $232.2 million. The second alternative, shown as increment IX, is CDM's proposed least costly method of attaining the States' water quality standards and could be completed at an estimated cost of $229.1 million.

The costs to complete each of the nine increments and the estimated water quality that would result from the completion of each increment are shown on the overlay on the next page.



DISSOLVED OXYGEN PROFILES RESULTING FROM EACH INCREMENT OF CONSTRUCTION FOR 1976 BOD LOADS

These costs do not include an estimated $140 million required to solve the pollution problem caused by the use of combined storm and sanitary sewers. These projections indicate the importance of planning in advance for water pollution control, since FWPCA and the States apparently were not aware that the States' water quality standards would not be achieved by following the construction implementation schedules proposed by the States and apparently were not aware of the effect that the construction of individual facilities would have in improving water quality.

We believe that the utilization of systems analysis could also provide current information on the water quality to be expected after waste treatment plants are constructed. Such information would enable the States to adjust their construction implementation schedules as necessary so that the water quality standards could be achieved. In addition, such information would be useful should the States desire to revise their standards.

Alternative construction implementation schedules

CDM developed an alternative construction implementation schedule based on projected 1976 pollution loads and determined the results in terms of water quality that would be achieved on the Merrimack River. These results were compared with the fourth increment of the States' implementation schedules, as follows:

River water classification (note a)	States' implementation schedules (increment IV)	CDM alternative schedule
B	84.2 miles	84.2 miles
C	45.0 "	87.4 "
D	42.4 "	-
Total	171.6 "	171.6 "
Cost	$154 million	$144.8 million

[a] Class B water is suitable for bathing, recreation, and agricultural uses and is acceptable, with filtration and disinfection, as a public water supply. Class C water is suitable for boating and irrigation of certain crops and as a habitat for fish and wildlife. Class D water is suitable for the transportation of sewage and wastes and for power, navigation, and other industrial uses.

Under the alternative schedule developed by CDM, the same number of miles of class B water could be provided as under the States' implementation schedules but at a cost of about $9.2 million less than under the States' schedules. In addition, under the CDM alternative schedule, more than 42 additional miles of the river could be upgraded from class D to class C water. Increment IV of the States' implementation schedules was utilized for comparison purposes because it was the first increment that would have resulted in the elimination of nuisance conditions in the river.

CDM indicated also that nuisance conditions could be eliminated by constructing only secondary treatment plants at Manchester, New Hampshire, and Lawrence, Massachusetts, at a cost of about $70 million, or about $84 million less than the cost of eliminating nuisance conditions after completion of increment IV of the States' implementation schedules.

Assimilative capacity and treatment levels

Pollution abatement is extremely expensive. For this reason, we believe that the assimilative capacity of a river should be considered in establishing interim objectives or goals. This factor is of particular importance in determining the level of treatment required, that is primary, secondary, or tertiary, and in establishing priorities for scheduling the construction of waste treatment plants at various locations.

According to the CDM study, the construction costs of providing secondary treatment plants at all locations on the Merrimack River, as advocated by FWPCA, would be slightly greater than CDM's least-cost alternative. If the CDM alternative were used, 10 secondary treatment plants would be replaced by nine primary treatment plants and one tertiary treatment plant. In our opinion, it would also result in considerable annual savings to the municipalities in operation and maintenance costs. On the basis of available statistical data, we estimated that the costs of operating secondary treatment facilities of the size and type that probably would be built for the municipalities on the Merrimack River would be 50 to 100 percent more than the costs of operating primary treatment facilities. The following table shows a comparison of estimated annual operation and maintenance costs between primary and secondary treatment plants of various sizes.

Size (flow in millions of gallons a day)	Estimated annual operation and maintenance costs		Ratio of primary treatment costs to secondary treatment costs
	Primary treatment	Secondary treatment	
0.1	$ 5,930	$ 6,360	1 to 1.1
1.0	22,900	34,100	1 to 1.5
10.0	88,400	183,000	1 to 2.1
100.0	357,000	983,000	1 to 2.8

Cost of providing additional water uses

The CDM report stated that, to maintain class B water, that is, water suitable for swimming and other water-contact sports, all upstream sewage discharges, including combined-sewer overflows, must be adequately disinfected prior to discharge.

The Massachusetts and New Hampshire water quality standards for the Merrimack River provide for about 47 miles of class B water below Concord, New Hampshire. CDM estimated that it would cost about $370 million, on the basis of projected 1976 waste loads, to construct the waste treatment facilities required to meet the States' water quality standards. CDM estimated also that, if swimming and other water-contact sports were not proposed uses of the Merrimack River below Concord, a construction program of about $150 million would be required to provide water of sufficient quality to meet other planned water uses, such as fishing and boating.

We are not trying to imply that water-contact sports should not be an ultimate objective for locations on the Merrimack River. We believe, however, that the desirability of providing for such uses should be weighed against the estimated additional costs of about $220 million necessary to achieve such an objective.

FACTORS TO BE CONSIDERED IN IMPLEMENTING A SYSTEMS ANALYSIS METHOD

In implementing a systematic approach to water pollution control, the factors discussed below should be considered.

Pollution effects on a river basin

Our review and the CDM study showed the importance of considering a river basin in its entirety, without regard to the political boundaries of States or municipalities. Generally water pollution from one State or municipality affects another State or municipality. Water pollution problems, however, have been historically treated as individual State or municipal problems and, as such, States or municipalities have given insufficient consideration to the effect of pollution on waterways outside their own boundaries.

For example, Massachusetts, when it completes the implementation of its construction schedule would be providing secondary treatment for all significant waste discharges into the Merrimack River but, as shown by the CDM report, would not meet its water quality standards because only primary waste treatment would be provided at Manchester which is located upstream. Thus the action taken by New Hampshire has a significant effect on the river in Massachusetts. A solution to problems of this nature may be to establish river basin authorities that would be responsible for planning the water pollution abatement procedures to be undertaken and for deciding which waste treatment plants should be constructed.

CDM's study showed that the States' dissolved-oxygen standards on the Merrimack River could be met by constructing only four tertiary plants at a cost of about $130 million. Although we recognize that this alternative might not be feasible, since other factors in the water quality standards, such as coliform bacteria, were not considered, CDM's study points out the possible alternatives available, as well as the inequities that could result in the implementation of a least-cost construction program. In this case four communities would be required to absorb all the local--other than State and Federal--costs associated with abating pollution on the Merrimack River.

A solution to problems of this nature might be a requirement that all sources of pollution on a waterway share in the cost of pollution control, perhaps through charges based on the quantity of wastes discharged by each source in relation to the total wastes discharged into the waterway and not to the level of treatment provided. Funds collected in this manner could be used to fund the State and local share of the construction costs of waste treatment plants and also for operating costs.

Mr. Charles L. Schultze, former Director of the Bureau of the Budget, in his book "The Politics and Economics of Public Spending," stated that:

> "The long term effectiveness of pollution control measures will be substantially shaped by the system of user charges designed to pay for the cost of pollution control facilities. Because the facilities built by an upstream community will reduce the pollution faced by a downstream community, user charges must be calculated and assessed in terms of inter-community effects."

Organizational structures available for implementing water pollution control programs

There are various organizational structures which could be used to accomplish water pollution control objectives and which would be susceptible to the use of systems analysis techniques. Some advantages and disadvantages of these alternatives are briefly discussed in the following sections.

River basin and interstate authorities

Pollution does not respect geographical or political boundaries. CDM's study of the Merrimack River pointed out that New Hampshire could meet its water quality standards by providing only primary treatment at certain locations. However, by New Hampshire's providing only primary treatment at one such location--Manchester--Massachusetts would be precluded from meeting its standards, even if it provided secondary treatment at all locations. A coordinated approach to water pollution control through a river basin or interstate authority responsible for controlling pollution from all sources on a river basin could prevent such problems.

One of the problems in implementing a river basin approach is that each State within a basin would be required to give up some autonomy to a river basin authority. The establishment of such an authority might be a time-consuming procedure, since it would probably require legislative approval by the respective States.

An alternative to the river basin authority, would be an interstate compact commission. Under this arrangement the States and the commission could jointly establish standards and plans for water pollution control. Although this type of commission would not require the States to give up their autonomy, it might tend to function slower since two or more organizations, that is, the commission and the respective States, would share the responsibilities.

State authorities

A proposal has been advanced in the State of Maryland for a State-wide Waste Acceptance Service (WAS). Under this proposal WAS would have total responsibility for planning and implementing water pollution control measures. Ownership and operation of all waste treatment plants and the responsibility for the construction of new plants would be vested in WAS. WAS would be financed through user charges assessed against all polluters. Although such an organization might be effective for combating pollution within a State and would not be faced with the political problems of the river basin or interstate organizations previously discussed, the problem of implementing a coordinated plan with municipalities in other States through which an interstate waterway flows would still exist.

State-local control

The most common approach now employed for planning and implementing water pollution control programs is a combination of local--that is, municipal or regional sewer districts--and State water pollution control agencies. Under this approach, State agencies have established water quality standards and implementation schedules and local governments have the responsibility of constructing and operating waste treatment plants, sometimes with State financial assistance. The States generally have the authority to issue orders requiring local governments to construct waste treatment plants, but this approach has often not been successful. As shown by the examples in chapter 4, the major problem with this approach has been the lack of a coordinated effort by all polluters in a river basin.

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A systems analysis approach to planning and implementing water pollution control programs could be undertaken under any of the organizational structures described above, each of which has its advantages and disadvantages. In our opinion, however, the river basin approach would increase the effectiveness of the systems analysis techniques employed.

Assimilative capacity of waterways and alternative levels of treatment

In May 1966 FWPCA issued guidelines requiring that wastes discharged into interstate waterways receive the best practicable treatment which in most cases, according to FWPCA, means secondary treatment. Such a requirement does not consider the differences in the assimilative capacities of various waterways.

CDM stated in its report that pollution abatement was extremely expensive and that it therefore was essential that:

> "*** only the most necessary and efficient works be constructed to accomplish the purpose. Full

> consideration should be taken of the natural self-purification powers of the environment to reduce the extent of the man-made efforts required."

The examples included in chapter 4 indicate the importance of considering the assimilative capacity of a waterway in planning for water pollution control. Example 2 shows that, even with a high level of waste treatment on a river, water uses are severely impaired due to its low flows and small assimilative capacity. In this case, all municipalities in the river basin were providing secondary treatment. In addition, industries were treating their wastes at municipal waste treatment facilities, which had resulted in a reduction of about 90 percent in the BOD being discharged into the river.

On the other hand, wastes discharged into a section of the river referred to in example 5 have increased by about 250 percent in the past decade; however, the water quality has apparently not deteriorated because of the large assimilative capacity of the river. No secondary treatment plants had been constructed by municipalities along this section of the river.

We believe that secondary treatment of wastes may be a desirable long-range objective. As stated previously, however, it is our opinion that, because of the magnitude of the construction program and the limited funds available, interim objectives or goals should be established. Such interim objectives could include the attainment of the States' water quality standards. We believe that the assimilative capacity of waterways should be considered in planning for the construction of waste treatment plants. In some cases, secondary treatment at all locations will be insufficient to maintain the desired quality of a waterway, while in other cases only primary treatment may be necessary.

The use of systems analysis in considering such various factors as pollution loads and assimilative capacity of waterways will assist planners in determining the facilities needed to obtain a specific water quality.

Need to treat major sources of pollution

The examples discussed in chapter 4 show that conditions on many waterways were not appreciably improved after waste treatment plants had been constructed, because, in many cases, (1) there had not been a coordinated construction program to abate pollution and (2) Federal grants were approved to provide treatment for relatively minor sources of pollution on waterways while major polluters continued to discharge untreated or inadequately treated waste into the same waterways.

The CDM study pointed out the importance of treating the major or more critical sources of pollution first. The report indicated that secondary treatment at Manchester, a major and critical source of pollution, would result in an immediate improvement of the river throughout Massachusetts. Further, by providing secondary treatment at Manchester and at Lawrence--another major source of pollution--nuisance conditions could be eliminated in the entire river on the basis of estimated 1976 waste loads. CDM also stated that, until these two communities provide the required treatment, the improvement in the river will be minimal, regardless of the funds provided for treatment facilities at other locations.

We found that the New Hampshire construction implementation schedule provided for primary treatment at Manchester in 1977, with no definite provision for conversion to secondary treatment. Furthermore when the implementation schedules of both States have been completed, about 10 percent of the river will still be below the water quality standards established by the States if only primary treatment is provided at Manchester.

We were informed by New Hampshire officials that, at an enforcement conference concerning pollution of the Merrimack River held in December 1968, they agreed to provide secondary treatment at Manchester if the State legislature would approve prefinancing legislation. Legislation authorizing the prefinancing of a secondary treatment plant in Manchester was approved in July 1969. This legislation, however, did not appropriate the funds needed for this purpose. We have been informed by a New Hampshire official that, if funds are appropriated when needed, Manchester will provide primary treatment by December 1975 and secondary treatment by December 1976.

ADP capability and collection of data

As indicated in CDM's report, systems analysis uses data which is usually obtained from river studies and analyses. The amount of time required to collect and analyze the data is dependent on the extent to which the river has been studied previously. For example, CDM was able to complete its study on the Merrimack River in about 4 months due to the fact that the river had been studied extensively over a long period of time. On the other hand, 2 to 5 years may be necessary if a river has not been studied extensively.

A systems analysis approach to water pollution control problems, such as that performed by CDM, may be practicable only if sufficient computer capability is available. We recognize that many of the State water pollution control agencies do not have the necessary funds or technically-trained personnel to implement this approach. We believe, however, that both the data collection and analysis, as well as the computer operations, could be cooperative ventures of the States and FWPCA.

We noted during our review that FWPCA had developed and was operating a STORET system which utilizes computers and that FWPCA is currently in the process of gathering considerable data. This system utilizes chemical, physical, biological, water, and waste treatment facilities data from about 23,000 reporting stations, much of which is the same or similar to the data required for a systems analysis approach.

In its system FWPCA has also included data on the States' water quality standards, implementation schedules and program plans, and an inventory of existing waste treatment facilities. This system utilizes the same type of computer as was used by CDM in its study. The system is already tied in by remote terminals to many FWPCA regional offices and field locations, and FWPCA is studying the practicality of providing access to the system to State water pollution control agencies.

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We believe that a systems analysis approach to planning and implementing water pollution control programs, similar to the method developed and demonstrated by CDM, is both feasible and practicable. The use of systems analysis as a tool to aid management should, in our opinion, result in improving the administration of the FWPCA construction grant program. A systems analysis approach would provide decisionmakers with more meaningful data so as to enable them to evaluate results, in terms of improved water quality, which may be expected to be achieved by the construction of one waste treatment facility or various combinations of waste treatment facilities. A decisionmaker would then be able to evaluate the reasonableness of a construction schedule and to consider a variety of alternative interim benefits that may be achieved.

Through the systems analysis approach to planning and implementing water pollution control programs:

--A least-cost construction plan to achieve water quality standards can be developed that considers the assimilative capacity of waterways.

--More costly, but perhaps more desirable, alternative schedules can be developed.

--Responsible officials can determine the level of treatment required to achieve an established objective and the costs of providing various levels of water uses.

CHAPTER 7

FEDERAL, STATE, AND CONSULTANT'S COMMENTS AND OUR EVALUATIONS

On September 25, 1969, drafts of this report were submitted to the Department of the Interior; the Office of Science and Technology, Executive Office of the President; the State water pollution control agencies of the eight States included in our review; and CDM.

The recipients agreed, in general, with the findings discussed in the report. The Department of the Interior agreed with all of our recommendations but disagreed with some of our conclusions. Some of the States did not agree with some of our conclusions and recommendations. The comments of the Department of the Interior, the Office of Science and Technology, the States, and CDM and our evaluations thereof are discussed below.

DEPARTMENT OF THE INTERIOR

By letter dated October 17, 1969 (see app. II), the Department of the Interior, in commenting on the matters discussed in this report, stated that it

--agreed with the report's basic premise that more systematic means of awarding construction grants must be found to secure greater benefits in pollution abatement;

--agreed that there was a need for the States, in establishing priorities for the construction of waste treatment facilities, and for FWPCA, in approving grants for such construction, to give consideration to the (1) benefits to be derived from the construction of the facilities and (2) actions taken, or planned to be taken, by other polluters of the waterway;

--fully agreed that the systems approach should be applied where it could make a significant contribution to pollution abatement;

--fully concurred in the need to make the STORET system available for utilization by the States; and

--completely agreed with the need to consider water pollution control on a river basin or regional basis.

The Department stated also that, in developing its legislative proposals for long-range extension of the construction grant program, it would take into consideration our proposal that:

> "*** the Congress may wish to consider amending section 8(a) of the Act to provide that priorities for grant awards be established on the basis of benefits to be realized."

Although the Department stated that it agreed with the report's basic premise and three proposals, it disagreed with several of our conclusions. The Department stated that:

> "Since as a general rule State political leverage on a community may be presumed to be inversely related to cost effectiveness of investment, it is not difficult to see why the small community often builds its plant first. Then because of inadequate improvement in stream quality, its weight is added to pressures for action by the larger community or industry. However obvious the situation, the way to implementation of the most cost effective investments first has not been so obvious."

The Department seemed to imply that it was easier to pressure small communities, which contribute relatively little pollution, to construct waste treatment facilities than it was to pressure larger communities or industries that might be major polluters. Our review showed that oftentimes communities that were minor polluters had constructed waste treatment facilities but that, even after the passage of several years, major polluters located nearby had not constructed treatment facilities and that the quality of the waterways had not improved appreciably.

Thus we believe that the Department's approach has not been totally effective in the past in reducing water pollution and that in the future greater pressure, including enforcement actions, may be required to improve the effectiveness of the construction grant program.

The Department stated that, although it agreed that the present levels of funding had not been adequate, it could not agree that interim goals should be established. The Department stated also that its goal was to overcome the vast backlog of unmet waste treatment needs and to bring the Nation abreast of the pollution problem of its cities over the next 5 years. The Department stated further that it had greatly strengthened its enforcement activities which were an important means of securing more rapid progress.

We agree that strengthened enforcement activities should aid in achieving more rapid progress *if* such actions are taken against major polluters. In our opinion, however, it is doubtful that the construction of all necessary waste treatment facilities could be completed in 5 years. In 1967 the Department also had a goal to complete the construction program within 5 years, or by 1972. It is obvious now that the program will not be completed by 1972.

In view of the significant expenditures required for the construction of municipal waste treatment plants, industrial waste treatment plants, and joint municipal-industrial plants and for the solving of the combined storm-sanitary sewer problem, we believe that Federal funds of many billions of dollars will be required. Even if such Federal funds could be made available, we believe that many municipalities, industries, and States would have difficulty meeting a 1974 target date for completion of all construction of waste treatment plants.

Another factor to be considered is the problem of operating and maintaining waste treatment plants. We found, while making another review, that many existing plants were not being properly operated and maintained and that there were not sufficient numbers of qualified personnel to operate the plants. Thus, even if the Department could complete the construction program in 5 years, the possibility exists that there would not be sufficient numbers of qualified personnel to operate and maintain the large number of plants that would be constructed during that period.

We continue to believe that under these circumstances interim goals should be established to attain water improvement objectives on specific waterways.

The Department advised us that it did not concur that less than secondary treatment would represent an adequate national policy at this time, except in the case of some coastal waters. The Department stated that, if it were to make effective progress, a substantial reduction of pollution from all municipal and industrial sources would be necessary. The Department stated also that secondary treatment, and treatment levels beyond that, should be considered a necessary goal to allow it to get ahead of the pollution problem.

We never suggested that less than secondary treatment should represent a national policy at this time or at any time. As stated in this report, we believe that secondary treatment may be desirable as the ultimate objective. However, because we agree with the Department that a substantial reduction of pollution from all municipal and industrial sources is necessary and because it is doubtful that sufficient funds will be available for the construction of secondary treatment facilities at all sources of pollution in the next few years, we believe that, as an interim measure, consideration should be given to providing less than secondary treatment when such treatment will result in enhancing water quality or in attaining the States water quality objectives.

In those cases where no treatment is being provided, it seems to us that providing primary treatment would result in the enhancement of water quality and therefore would be better than no treatment. As stated on page 16, we believe that municipalities that are allowed to provide less than secondary treatment should be advised that, if circumstances change as a result of population and/or industrial growth or expansion, they may be required to upgrade their treatment facilities.

In its "Guidelines for Establishing Water Quality Standards for Interstate Waters," FWPCA stated that all wastes, prior to discharge into any interstate water, were to receive the best practical treatment or control unless it could be demonstrated that a lesser degree of treatment or control would provide for water quality enhancement commensurate with proposed present and future water uses. Our position is in complete agreement with these guidelines.

Furthermore, it appears to us that the establishment of water quality standards does not serve a useful purpose if an arbitrary requirement of secondary treatment is imposed on all polluters immediately.

With regard to the CDM study of the Merrimack River, the Department stated that:

> "We do not believe the study provides a pragmatic and effective guide to necessary pollution abatement actions in the Merrimack River. This conclusion does not reflect lack of competence on the part of Camp, Dresser, and McKee; on the contrary they have performed a creditable modeling study within a very short time period and within the limits of available data. Our conclusion stems largely from some fundamental limitations in the method, limitations which CDM and the General Accounting Office, to a large extent, have also identified.
>
> "These limitations are such that an attempt to directly apply the results of the CDM study at this time would, we feel, cause significant problems at State and local levels, resulting in an unnecessary delay in achieving pollution control

> goals and yielding an uncertain result in terms of water quality.
>
> "The limitations are of three types: technical, policy objectives, and feasibility of implementation." (See pp. 7 to 9 of app. II for details of the Department's discussion of the limitations.)

We never intended that the results of the CDM study should be directly applied to the pollution abatement program for the Merrimack River. Rather, the CDM study was undertaken to demonstrate the feasibility and practicability of applying systems analysis techniques to the water pollution problem. Furthermore, with regard to the Department's discussion of technical limitations, we have discussed in this report some of the parameters considered by CDM, as well as some of those not considered because of the short period of time that CDM had to complete its study. We stated, however, that the parameters not included could be considered and evaluated by use of the mathematical model developed by CDM by inserting the pertinent information into the computer program as input data.

In this regard, in commenting on a draft of this report, the Office of Science and Technology, Executive Office of the President, advised us that CDM had:

> "*** produced an effective systems analysis in this case, not so much because of their sophistication in the methodologies commonly known as systems analysis, but because of their excellent understanding of this highly complex system and its attendant problems."

OFFICE OF SCIENCE AND TECHNOLOGY EXECUTIVE OFFICE OF THE PRESIDENT

By letter dated September 29, 1969 (see app. III), the Office of Science and Technology stated that:

> "*** it is an excellent report; one which should be very helpful to the Congress and even more helpful to the Federal and State agencies which have been trying to get a handhold on this problem. A great many questions, problems and issues which have confused the picture are put in much better perspective."
>
> "Your conclusions and recommendations are sound, in my opinion."

The Office emphasized that the increased use of systems analysis to develop sound plans for implementing the Nation's water quality objectives should be under the direction of competent engineers thoroughly experienced in all aspects of water quality management and waste treatment systems.

STATE WATER POLLUTION CONTROL AGENCIES

Officials of the Louisiana and New Hampshire water pollution control agencies informed us orally in October 1969 that they agreed, in general, with the facts and conclusions as presented in our draft report.

The Executive Director of the Texas Water Quality Board (see app. VIII) informed us that:

> "*** The report as a whole appears to be satisfactory and the general conclusions offered *** are realistic. We are in general, although not absolute, agreement with these conclusions and would not take exceptions with your findings."

Officials of the Arkansas (see app. V), Maine (see app. VI), Massachusetts (see app. VII), Oregon (comments received orally), and Washington (comments received orally) water pollution control agencies agreed, in general, with the facts presented in our draft report. Oregon and Washington officials, however, stated that they did not believe that a systems analysis approach was a satisfactory solution to the water pollution problem. These officials, however, did not offer any alternative solution to the problem and stated that readiness to proceed should continue to be a primary consideration in awarding Federal grants for the construction of waste treatment facilities.

Our review showed that this type of approach had not, in many cases, accomplished water quality improvement objectives. We believe therefore that Federal construction grants should be awarded on a basis which considers (1) the benefits to be derived and (2) the actions taken, or planned to be taken, by other polluters along a waterway.

Also, we have not taken the position that systems analysis is the solution to the water pollution problem. Rather, we have stated that systems analysis techniques could be used by decisionmakers as an aid in managing their pollution abatement programs. As stated on page 18, the largely quantitative results of systems analysis should be used in conjunction with other information available to responsible officials in making decisions.

The Massachusetts, Oregon, and Washington agencies also expressed the opinion that a mathematical model, to be useful, must consider more parameters than were considered by CDM. We recognize, as does CDM, that a mathematical model dealing with water pollution must consider all pertinent factors that relate to water quality. Because we requested CDM to complete its study, model, and report to us by June 15, 1969, it was not able to consider all pertinent factors in its model. As a result, CDM limited its study to a dissolved-oxygen analysis with consideration's being given to BOD waste loads and to the problem of coliform bacteria. As stated on page 84, however, additional types of pollutants, such as phosphorous or dissolved salts, could be considered and evaluated by use of the mathematical model by inserting the pertinent information into the computer program as input data.

Water pollution control officials from the States of Arkansas and Massachusetts stated that secondary treatment should be required of all municipalities. We recognize in this report that secondary treatment may be desirable as an ultimate objective. We believe, however, that, in view of the limited resources available and the magnitude of the construction program, interim measures should be established whereby consideration could be given to less than secondary treatment when such treatment will result in enhancing water quality or in attaining the States' water quality standards.

CAMP, DRESSER & McKEE

By Letter dated October 3, 1969 (see app. IV), CDM, in commenting on the matters discussed in this report, stated that the facts presented were accurate and demonstrated a knowledgeable view of the problems.

APPENDIXES

CAMP, DRESSER & McKEE
CONSULTING ENGINEERS

WATER RESOURCES
WATER SUPPLY AND TREATMENT
SEWERAGE AND SEWAGE TREATMENT
INDUSTRIAL WASTE TREATMENT
REPORTS
DESIGN
DRAINAGE AND FLOOD CONTROL
WATER AND AIR POLLUTION
REFUSE DISPOSAL
RESEARCH AND DEVELOPMENT
SERVICES DURING CONSTRUCTION

THOMAS R. CAMP, EMERITUS
HERMAN G. DRESSER, EMERITUS

JACK E. McKEE
JOSEPH C. LAWLER
ROLAND S. BURLINGAME
DARRELL A. ROOT
JOSEPH E. HENEY
ROBERT C. MARINI
CHARLES A. PARTHUM
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RICHARD H. ESTES
DAVID R. HORSEFIELD
ROBERT P. PELLETIER
ELWOOD C. RICHARDSON
WILLIAM C. TRAQUAIR
RICHARD L. WOODWARD

ADMINISTRATIVE MANAGER
ROBERT F. JEWETT

June 16, 1969

United States General Accounting Office
John F. Kennedy Building
Boston, Massachusetts

Report on Development of a
Mathematical Model for
Minimizing Construction Costs
in Water Pollution Control
CDM 471-1

Gentlemen:

In accordance with the terms of the contract, dated February 18, 1969, between the United States General Accounting Office and Camp, Dresser & McKee, Consulting Engineers, we have conducted engineering studies and have developed a method for the determination of a least cost construction program to achieve water pollution control objectives within a drainage basin. A description of the method, its application and a demonstration of its usefullness are contained in the main body of the attached report. A summary of the report, together with our conclusions and recommendations follows.

Economic support for water pollution control by the Federal Government began with the enactment of the Water Pollution Control Act of 1956 and accelerated with the passage of (PL 89-234) the Federal Water Quality Act of 1965 and amended by the Federal Clean Water Restoration Act of 1966. Under the terms and authorizations of the cited Acts, the Federal Government is heavily involved, both financially and physically, in the efforts of States and municipalities to abate the pollution existing in the nation's surface waters.

Standards of quality established pursuant to this act shall be "such as to protect the public health or welfare, enhance the quality of water and serve the purposes of this Act. In establishing such standards, the Secretary, the Hearing Board, or the appropriate State authority shall take into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial and other legitimate uses."

Past neglect and the rapid growth of population and industry has resulted in the quantities of wastes being discharged to greatly exceed the efforts of local authorities to provide adequate treatment. The magnitude of the task of providing the necessary treatment to achieve the goals of the Clean Water Restoration Act of 1966 is clearly beyond the capacity of the available resources. It is, therefore, essential that the maximum utilization be made of all available financial resources in order that these goals may be reached. Failure to utilize the available resources with the maximum efficiency could result in such an intolerable burden that rejection of the program or a modification of its goals might result.

Recognizing the seriousness of the problem of water pollution and available financial resources, the General Accounting Office is performing a review to examine into the effect of the Federal Grants in Aid Program and the policies and the practices of the Federal Water Pollution Control Administration in achieving the intent of the Clean Water Restoration Act of 1966. As a part of its review, the General Accounting Office desired to develop a method which might serve as a tool to assist the Federal Water Pollution Control Administration and the pollution control agencies of the States in achieving maximum benefits from Federal and State funds assigned to pollution control. The General Accounting Office recognized the fact that its staff lacked the technical competence in the field of water pollution control needed to develop the desired method. The General Accounting Office therefore, engaged Camp, Dresser & McKee, Consulting Engineers, to provide the necessary technical background. A method, or technical tool, for the engineer to evaluate construction costs for achieving the goals of the Clean Water Restoration Act of 1966 at minimum cost, has been developed.

SUMMARY

Objectives of the Study

The objective of the study was to develop a method to accomplish four specific purposes. These were:

1. To minimize the overall costs based on cost of treatment plants for achieving the goals of the Federal Water Quality Act of 1965 and the Clean Waters Restoration Act of 1966.
2. To provide a method for determining the minimum cost for achieving particular intermediate goals less than those established as the ultimate objective.
3. To develop a means of determining what water quality improvements could be expected from the expenditure of stated limited funds, in the event that funds were not available for the accomplishment of the entire project.

4. To develop a method which would provide State and Federal agencies with clearly defined alternative programs together with the costs and water qualities associated with those alternatives.

A river is a vital, living community containing many life forms in vast numbers. The river provides all of the necessities for the maintenance of its inhabitants. It provides water, food, oxygen, and disposal of waste products. In order to maintain the health of this river community, it is necessary that these essential elements be maintained in an equilibrium. Economic considerations (under the criteria of economic efficiency) dictate that maximum utilization be made of the ability of the river community to accept, ingest and dispose of human wastes. The river is a unit and must be considered in its entirety. A discharge of pollution into a river affects the entire river downstream from the point of pollution. Hence, in order to maintain the most economical balance of on-shore treatment and waste discharge, it is necessary to simultaneously consider all points of treatment and pollution and integrate them into a unified treatment program. Unfortunately, this is not always possible where rivers traverse more than one political jurisdiction. Too often in such situations, political considerations take precedent. The present study ignores political jurisdictions and develops methods most economic for a river basin as a whole.

When funds are not available to completely abate all pollution entering a river, it becomes a matter of importance to determine the cost of achieving certain limited objectives. For example, it might be desirable to know the minimum cost of improving the quality of a river so that bathing would be possible, without necessarily achieving an environment suitable for the propagation of trout and other delicate fish. The method developed by our study permits such costs to be determined either for the river as a whole, or for specified parts of the river.

On the other hand, often only a fixed sum of money is available to allocate to pollution control. Faced with this problem, it is essential to know to which of many projects this money may be expended to yield the highest immediate return in the form of additional water uses. Employment of the methods developed by the present study permit the alternatives for which limited funds may be expended to be examined and the resulting benefits forecast. Furthermore, the method develops in explicit terms, the quality of water as expressed by the dissolved oxygen parameter throughout the entire length of the river which will result from the expenditure of a fixed sum of money at one or more specific locations.

The method which has been developed is extremely flexible in that it provides for the insertion of numerous conditions both for the present circumstances and for conditions projected into the future. With this flexibility, various schemes can be tested and a determination made of results of a particular program or plan. Through use of the method, those expenditures which result in little or no improvement to the water quality can be quickly eliminated from further consideration. This method also can indicate the minimum sum of money required to achieve any desired benefit or water quality.

The basis of this flexibility lies in the use of an electronic computer for performing the numerous computations involved. Without the availability of an electronic computer, it would not be feasible to employ the proposed methods. The method is designed to be a living planning device. As conditions change and as more and better data become available, the computer program can be adjusted to reflect these facts. Such flexibility prevents obsolence of the method and results in a tool which becomes sharper and more precise with use.

Description of the Method

After a great deal of investigation and study, the various States have established water quality standards which they consider to be desirable for the waters of their individual states. These standards have been approved by the Secretary of the Interior with some exceptions. These standards form the basic objectives and goals of the Federal Water Quality Act of 1965 and the Clean Waters Restoration Act of 1966. Establishing a particular equilibrium at minimum cost, it is first necessary to understand the life processes of the stream in question. Such understanding requires an intimate knowledge of the stream. The necessary knowledge of the stream is acquired through a study of the watershed, the prevailing weather conditions, the physical characteristics of the stream, the chemical composition of the water, the flora and the fauna living in the stream and the characteristics of the wastewater being discharged therein. Finally, it is necessary to estimate the costs of construction of various types and degrees of wastewater treatment for each source of pollution both present and future and to integrate these costs into the analysis of the system.

It is not possible to express the reactions which occur in a river by an exact mathematical formulation, because the river is a biological system. However, in about 1925, H.W. Streeter and E.B. Phelps, workers employed by the United States Public Health Service, developed a general mathematical formulation representing, with a fair degree of accuracy, the relationship between organic pollution and the dissolved oxygen level in a river. Although the Streeter-Phelps relationship is not precise, it has been of great value to engineers in understanding and interpreting the sanitary condition of many rivers. A recent modification, as described in the body of the report of the Streeter-Phelps relationship, has been proposed by T.R. Camp. In formulating the present method of analyzing river conditions, we have utilized the Camp modification of the Streeter-Phelps equation, which is given below:

$$D_t = \frac{k_1}{k_2 - k_1 - k_3}\left[L_a - \frac{p}{2.3\,(k_1 + k_3)}\right] 10^{-(k_1+k_3)t} - 10^{-k_2 t}$$
$$+ \frac{k_1}{k_2}\left[\frac{p}{2.3\,(k_1 + k_3)} - \frac{a}{2.3\,k_1}\right](1 - 10^{-k_2 t}) + (D_a)\,10^{-k_2 t}$$

At the present time, the equation is a widely accepted mathematical relationship used for estimating the effects of pollution on a stream.

As is well known, the occurrence of rainfall is quite variable and unpredictable. Therefore, as might be expected, the flow in rivers and streams is extremely variable. A normal stream on the eastern seaboard may range from a low of 5 per cent of the average yearly flow during droughts to a maximum of several thousand times the average yearly flow during periods of flood. Pollution abatement works cannot be designed for the average yearly flow in the stream because such a procedure would leave the stream in an excessively polluted condition for much of the time. It is, therefore, necessary to select the river flow for which the pollution abatement works are designed. Many State pollution control agencies have selected a flow equivalent to the average flow during the seven consecutive days of low flow, which occurs once in ten years. In many eastern rivers, the flow described above will be exceeded about 98 per cent of the time. For the purposes of this report, we have adopted this particular flow. However, the proposed method lends itself to the utilization of any desired flow.

Another measure of the sanitary quality of water is a measurement of the most probable number (MPN) of coliform bacteria. Coliform bacteria are non-pathogenic inhabitants of the intestinal tract of all animals, including man. They are discharged from the intestinal tract in huge numbers (between 2 and 4 billion per day). The test for the presence of coliform bacteria in water is relatively easy and requires a minimum of skill on the part of the analyst. On the other hand, disease producing pathogenic bacteria occur in small numbers and are very difficult to detect, even in a highly polluted water. For these reasons, Public Health Authorities have adopted the coliform index as a measure of the sanitary quality of the water. The presence of coliform bacteria is presumed to indicate the possible presence of human wastes and a potential source of disease. However, since coliform bacteria are widely distributed in nature, the presumption of the presence of disease producing bacteria is somewhat tenuous. We are of the opinion that for the purposes of evaluating the safety of the water for water contact sports, the coliform index has little, if any, value. Since there is no reliable measure for the presence of disease producing bacteria and viruses in the water, we have adopted the policy that all upstream discharges of sanitary sewage must be disinfected before discharge if the river downstream is to be used for contact sports. Satisfactory disinfection may be achieved by primary sedimentation of the sewage together with chlorination by the addition of at least 20 mg/l (milligrams per liter) of chlorine. This procedure should eliminate all disease producing bacteria and many of the viruses. We consider this to be the minimum requirement to safeguard the public use of the water downstream for contact sports.

In order that the method developed would have the widest possible use, the following criteria were employed in its development:

1. The method is based upon the best current practice among engineers who conduct stream studies. The method does not utilize experimental, controversial or little understood formulations or practices. The method does not consider as design variables, staging of construction, low flow augmentation or operating costs.
2. The method is usable by engineers engaged in this type of work.
3. The method has practical application.
4. The amount of detail included in the method is limited to the essential in order that the results will not be obscured by a mass of miscellaneous minor details.
5. The method uses data which is usually obtained from results of river studies. However, for rivers which have not been subjected to extensive study, a two to five year period may be required to obtain the data needed.

A study of the qualities and characteristics which are utilized by engineers to assess the sanitary quality of a river or stream indicates that the cost determining characteristic is the dissolved oxygen content of the water. Treatment for the removal of other polluting substances from the wastewater becomes incidental to the removal of oxygen demand material. The universal thread which passes through nearly all treatment works is the removal of oxygen consuming materials from the wastewater. Hence, the basis of the mathematical models employed in the method developed by this study is related to the dissolved oxygen concentrations along the length of the river, as shown in the dissolved oxygen profiles of Figures 1 and 2, together with the costs associated with obtaining these concentrations.

Before the method can be applied, it is necessary to assemble and analyze all of the data needed. The data required are listed below:

1. A physical description of the watershed.
2. A physical description of the stream. (Profiles of the stream bed and the water surface).
3. Stream flow records from all existing gaging stations.
4. Results of a sanitary survey of the stream.
    a. The measurement of dissolved oxygen at numerous stations.
    b. Measurement of the pollution (BOD)[1] present at numerous stations.
    c. Measurement of pollution loads at each sewer outfall.
    d. Measurement of de-oxygenation rates.
    e. Measurement of river water temperatures.
5. Population data for each city and town and future projections.
6. Industrial waste survey of each industry discharging liquid wastes and future projections.
7. Preliminary designs of the needed sewers and pollution abatement works for each individual polluter.

---

[1] Biochemical oxygen demand - the quantity of oxygen utilized in the biochemical oxidation of organic matter measured as an amount over a period of time at a certain temperature, (usually 5-day, 20°C demand in lbs).

8. Estimated costs of construction for each individual pollution abatement works.

In the United States, some sources of the above data are as follows: U.S. Geological Survey, U.S. Corps of Engineers, Federal Water Pollution Control Administration, U.S. Bureau of the Census, State Health Departments, State Water Pollution Control Authorities, Engineering Departments of various cities and towns, Engineering Departments of industries on the watershed and Consulting Engineers of various cities and towns.

After all of the data has been assembled, it will be necessary for the user of the method to critically examine all data and using his best engineering judgment, adjust the data into a consistent pattern. It is here that the highest degree of engineering skill needs to be used because the results will only be as good as the data employed.

Once the data has been assembled and interpreted, the user of the method may insert this data into the computer program. Using the data, numerous results can be quickly obtained. In a matter of a few minutes, the investigator can determine the changes effected in the dissolved oxygen profile for the entire river resulting from the construction of any pollution abatement works which he desires to investigate. He may also determine the minimum cost for achieving any desired dissolved oxygen level.

The results produced are only as good as the rate parameters used for them. If the state of the art of estimating these parameters were well advanced, engineers would feel confident of the results of the analyses. This is not always the case and much additional research may be necessary before the parameters can be estimated precisely. Current approaches consist of two steps; first, some of the parameters are measured by direct methods that are independent of the BOD and DO[1] sag equations and following this, values of the remaining parameters are developed in order to achieve a match between computed BOD and DO changes and measured BOD and DO changes over a reach of stream.

---

[1] DO - Dissolved Oxygen

More than one set of rate parameters can yield a match between computed and measured stream qualities. This is the case, not only when reproducing actual oxygen profiles, but when applying approximately parallel adjustments for forecasting future conditions. When parameters are adjusted for future conditions, however, good projections are not necessarily assured.

Despite the shortcomings of the current technology employing BOD and DO equations, they represent the best tools available for engineering decisions. It is well to keep in mind, however, that the actual quality conditions of the future may differ substantially from values estimated at this time.

In view of this, we emphasize the importance of engineering judgement in arriving at the best values of the parameters from the data collected in comprehensive stream studies.

If the desired water quality includes any characteristics in addition to the dissolved oxygen concentration, such as floating solids, grease, color, pH, dissolved solids, nitrogen, phosphorous toxic materials, heavy metals and coliform bacteria, the treatment necessary to abate this type of pollution may be determined by use of the proposed method. The insertion of the proper information in the data input of the program will enable the mathematical model to evaluate such pollutants.

The solution of the mathematical model developed, as a result of this study, for minimizing construction costs in water pollution control utilizes two computer programs.

The first program is described as a mixed integer program. Basically, the mixed integer program is used for determining the minimum cost to achieve specified dissolved oxygen levels throughout the length of the river.

The second computer program is called a simulation program. The simulation program is utilized to portray the dissolved oxygen profile or the profile of conservative[1] pollutants along the entire length of the river resulting from any series of stated pollutional loads. Using the programs in various combinations it is possible to generate the answers to pertinent questions needed for the development of an efficient pollution abatement program.

RESULTS

A demonstration of a proposed method of analysis to a real situation provides proof of its usefulness. The Merrimack-Pemmigewassett River, a medium sized river in New Hampshire and Massachusetts, hereinafter referred to as the Merrimack River, was selected for the demonstration. The Merrimack-Pemmigewassett river system is shown by the following map. The Merrimack River was selected because of the large amount of data available relative to sources of pollution, river characteristics and costs of proposed pollution abatement works. A description is contained in the main body of the report. The results of the analysis are discussed below.

The States of New Hampshire and Massachusetts have classified the waters of the Merrimack River along its entire length. Various reaches of the river have been classified B, C, SB or SC depending upon their locations and proposed schedule for the construction of wastewater treatment works. The Secretary of the Interior has approved the classifications and the implementation schedules. As a part of the present study, the implementation schedules were examined by the proposed method of analysis.

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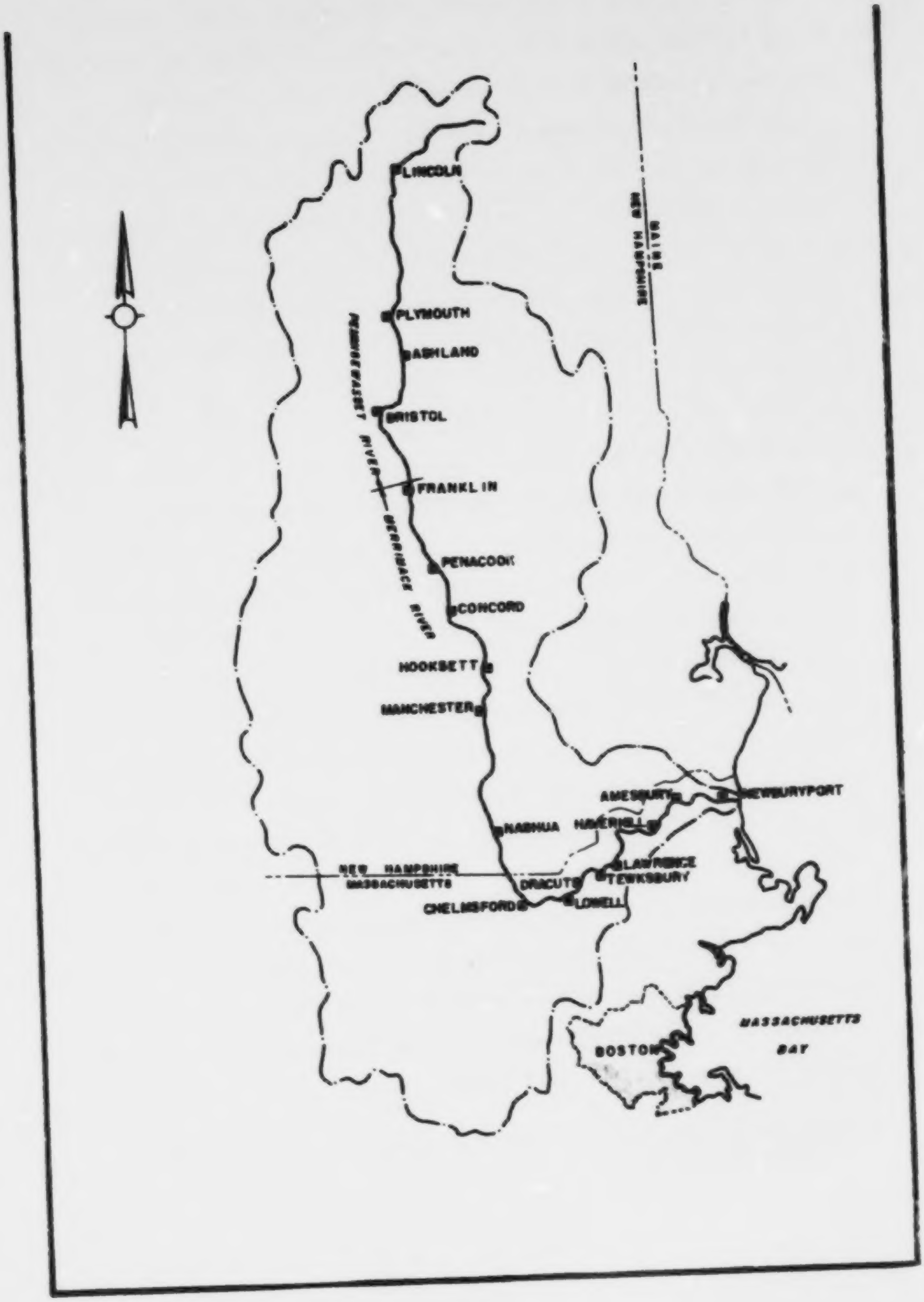
[1] Conservative pollutant - pollutant that is not affected by biochemical reactions in streams


LINCOLN
MAINE
NEW HAMPSHIRE
PLYMOUTH
ASHLAND
PEMIGEWASSET RIVER
BRISTOL
FRANKLIN
MERRIMACK RIVER
PENACOOK
CONCORD
HOOKSETT
MANCHESTER
AMESBURY
NEWBURYPORT
NASHUA
HAVERHILL
NEW HAMPSHIRE
MASSACHUSETTS
LAWRENCE
DRACUT
TEWKSBURY
CHELMSFORD
LOWELL
MASSACHUSETTS
BAY
BOSTON

The implementation schedules, as shown in Table 1, are divided into seven yearly increments from 1969 through 1977. Also, three alternate treatment schemes are presented. Lack of sufficient funds for pollution abatement has rendered the schedule obsolete insofar as the timing is concerned, however, if the proposed increments are considered to have no specific time span, they represent the proposed order of construction. The results of carrying out the existing State's schedules are presented in Tables 2 and 3 and shown in Figs. 1 and 2 for the pollution conditions in 1976 and 1995, respectively. Each line in these figures is a computed dissolved oxygen profile of the river during the most critical season of the year resulting from each successive stage of the proposed schedule of construction. The cumulative sum of the estimated costs of construction (based on projected costs for 1974) as each increment is completed, is shown in the box in each figure. The costs shown do not include the cost of treatment of storm water overflows.

The heavy horizontal lines indicate the dissolved oxygen concentration called for by the classifications. The curving lines are the computed dissolved oxygen profiles. The solid curving lines are the critical dissolved oxygen profiles for 1976 and 1995 if no pollution abatement works are constructed. A dissolved oxygen level less than 1.0 mg/l (milligrams per liter) is considered to be approaching nuisance conditions (odors and unpleasant appearance)in the water. A higher dissolved oxygen level (greater than 2.0 mg/l) is essential to support most fish life.

A consideration of Fig. 1 indicates that if no pollution abatement works are constructed by 1976, the river will be in a nuisance condition from Lawrence to Newburyport and about 70 percent of the river will be below the classification requirements After the first increment of the implementation schedule has been completed at an estimated cost of $8,300,000, about 15 per cent of the river will be in a nuisance condition and about 40 per cent will fall below the classification requirements.

Completion of increments II and III, at an additional cost of about $20,000,000, will result in little or no improvement in the dissolved oxygen levels. Completion of increment IV, at an additional cost of about $125,700,000, will reduce the length of the river not meeting the classification requirements to about 26 per cent. None of the river will now be in a nuisance condition.

The completion of increments V and VI, at an additional cost of about $48,000,000, will not change the profiles significantly. The completion of increment VII, full implementation of the State's improvement schedule, at an additional cost of $21,900,000, will leave about 10 per cent of the river in non-compliance. The completion of increment VIII, at an estimated cost of $8,300,000, will bring the river into full compliance with the specific DO levels. The total estimated cost is $232,200,000. This cost is for the treatment of dry weather flows only. For compliance with existing water quality standards provision for the treatment of storm water overflows from combined sewer systems must be achieved. The additional cost of this treatment to insure compliance with the water quality standards will add an estimated additional $140,000,000 in costs or a total estimated treatment cost of $372,500,000 for the river system.

Fig. 2 demonstates the conditions in 1995 if the existing State's implementation schedules are incomplete by that time. At that time, the reach of the river from Nashua to Newburyport, except for short reaches, will be in a nuisance condition unless increment IV of the implementation schedule has been completed at that time. Completion of increment IV is needed to prevent nuisance conditions throughout the river in 1995. Even with the completion of increment VII, the entire implementation schedule, will not insure full compliance with the classification requirements in 1995. Additional treatment over and above that called for in the schedule at an estimated cost of about $13,300,000, designated increment X, will be required. Increment XI on Fig. 2, indicates the dissolved oxygen profile if all reaches were to meet the requirements of the B classification.

Other implementation schedules may be developed and examined by this method. The evaluation of different schedules is a matter of subjective judgement. A schedule calling for the initial construction of secondary treatment works at Manchester would result in an immediate improvement throughout all of Massachusetts. Construction of secondary treatment works at Manchester and Lawrence alone will raise the entire river out of any nuisance condition at a cost of about $70,000,000. A schedule for immediate construction is shown in Table 4. The cost of construction is estimated to be $144,800,000, and will raise the water quality in the entire length of the Pemmigewassett River to B and the entire length of the Merrimack to C. This analysis points out the value of employing the available funds on the major sources of pollution first and the smaller sources later.

An examination of Fig. 2 points out the critical role that the cities of Manchester and Lawrence play in the dissolved oxygen of the Merrimack River. Until the pollution from these two cities is abated, the improvement to the river water quality will be minimal, regardless of monies expended in providing treatment works at other locations.

Also indicated is the importance of primary treatment with chlorination for aethetics and uses such as water contact sports. Secondary treatment of sewage from small communities has little effect on the dissolved oxygen profile.

CONCLUSIONS

There are a number of conclusions which may be drawn from a study of this type. Some of the conclusions are of a general nature and apply to nearly all pollution abatement programs, while others will apply only to situations similar to those existing in the Pemmigewassett-Merrimack River drainage basin.

General Conclusions

1. Pollution abatement is an extremely expensive undertaking. It is therefore, essential that only the most necessary and efficient works be constructed to accomplish the purpose. Full consideration should be taken of the natural self-purification powers of the environment to reduce the extent of the man-made efforts required. This is not to say that high goals should be compromised for the sake of economy, however, unnecessary expenditures should not be made.
2. Extensive advanced planning is necessary to determine the objectives and the means for the accomplishment of pollution abatement. It is only in recent years that appropriate tools and techniques have become available.
3. The method developed by the present study is an important tool which, when used by a group of skilled engineers, can furnish insights into the relationships between the natural self-purification processes, water quality and costs for pollution abatement works such that a selection of the least cost construction program to achieve desired goals may be selected with confidence.

4. The use of an electronic computer of sufficient capacity, is essential to the utilization of the proposed method. The computer used in this study was an IBM 360 Model 65. The full storage capacity of 250K was required for the Mixed Integer Program.
5. An extensive and time consuming collection and analysis of data describing the physical, chemical, biological and economical characteristics of a drainage basin is also essential to the planning process. Much additional research and development is needed to increase the precision with which the above characteristics can be evaluated. Although present methods may lack in precision, they clearly describe, with broad strokes, existing and projected future conditions. The accuracy to the proposed method will be increased as better data becomes available.
6. Planning and implementation of pollution abatement must be carried out on a river basin scale, regardless of political boundaries, if maximum economy is to be achieved.
7. Present legal and institutional constraints that interfere with the minimum cost solutions supplied by the model program, should be recognized and their values reviewed.

Conclusions from the Merrimack River Demonstration

1. Available and anticipated future funds for pollution abatement in the Merrimack River Basin are

completely inadequate to accomplish the water quality goals established by the concerned water pollution control administrations. The estimated cost of the least cost construction program, based on projected 1974 prices, is $372,500,000, including provisions for combined sewer overflows.

2. The proposed method of analysis can be used, to advantage, by the pollution control authorities to improve the staging of the construction program. Expensive construction of works which will result in little or no immediate improvement in water quality can be postponed while available funds can be allocated to those projects yielding the greatest immediate results.
3. The proposed method is flexible and is able to take into account all known parameters affecting water quality in its conclusions.
4. Water quality suitable for bathing and other water contact sports can only be attained when all upstream sewage discharges, including combined sewer overflows, are adequately disinfected prior to discharge.
5. Combined sewer overflows constitute important sources of pollution and must be fully evaluated in establishing construction programs. Combined sewer overflows upstream of secondary or tertiary treatment works, defeats the accomplishments of such treatment to protect recreational uses of the water.

Obviously, untreated combined sewer overflows affect, to some degree, the dissolved oxygen in the river, but the effect on the entire water quality of the river (floating solids, coliform bacteria, etc.) is considerable.

RECOMMENDATIONS

We recommend that pollution control administrators use the method described in this report, or modifications thereof, as an additional tool to reevaluate present water pollution abatement plans and to apply this method when the need for future planning occurs.

Where insufficient basic data exists in a river basin, the obtaining of this data by river flow measurements and physical, chemical and biochemical analysis is an essential first step.

ACKNOWLEDGEMENTS

We wish to acknowledge the contributions made to the development of the methods described in this report by Dr. George T. Bryant, Mr. Max S. Clark, III, Dr. Ching Seng Fang and Dr. Kuan-Mu Yao, all of Camp, Dresser & McKee and Professor Alvin S. Goodman of Northeastern University, Consultant.

Furthermore, we wish to acknowledge, with thanks, the staff of the Massachusetts Natural Resources Department, Water Pollution Control Division, the New Hampshire Water Supply and Pollution Control Commission, the Federal Water Pollution Control Administration and the U.S. Army Corps of Engineers, who supplied much of the data used in the demonstration of the method, who reviewed the preliminary draft of this report and furnished many suggestions which served to clarify the presentation. The cities and towns in the Merrimack-Pemigewassett River Basin cooperated with the study by furnishing copies of reports prepared by their consulting engineers.

We acknowledge, with thanks, the continuous support and encouragement of the Boston and Washington staff of the General Accounting Office.

Although all of the public agencies cited above contributed to the development and demonstration of the reported method, they have no responsibility for the method, the results, or the conclusions which are entirely those of Camp, Dresser & McKee. Assistance to Camp, Dresser & McKee by these public agencies should not be construed as an endorsement or approval of the method, the results or the conclusions.

Very truly yours,

CAMP, DRESSER & McKEE

Robert H Culver

Robert H. Culver
Associate
Project Engineer

Approved by

Charles A Parthum

Charles A. Parthum
Partner-in-Charge

TABLE I STATE STREAM POLLUTION IMPLEMENTATION SCHEDULE (COLS. I-VII)

Possible Alternative Treatment Schemes Indicated by This Study (Cols. VIII-XI)

Year		1969	1970	1971	1972	1973	1974	1977				
Increment Number		I	II	III	IV	V	VI	VII*	VIII**	IX***	X****	XI*****
1	Newburyport				S	—	—		S	P	S	S
2	Amesbury		S	—	—	—	—		S	P	S	S
3	Haverhill				S	—	—		S	S	S	S
4	Lawrence				S	—	—		S	S	S	T
5	Tewksbury								S	S	S	S
6	Lowell					S	—		S	S	S	S
7	Dracut				S	—	—		S	P	S	S
8	Chelmsford			S	—	—	—		S	P	S	S
9	Nashua				S	—	—		S	S	T	T
10	Manchester							P	S	T	S	S
11	Hooksett	P	—	—	—	—	—		S	P	S	S
12	Concord						P—		S	P	S	S
13	Penacook				S	—	—		S	P	S	S
14	Franklin			S	—	—	—		S	S	S	S
15	Bristol	S	—	—	—	—	—		S	P	S	S
16	Ashland	S	—	—	—	—	—		S	S	S	S
17	Plymouth	P	—	—	—	—	—		S	P	S	S
18	Lincoln	S	—	—	—	—	—		S	S	S	S

*Completion of present States' Implementation Schedules.
**All secondary treatment.
***To meet stream classification for 1976 pollution loads.
****Secondary treatment as minimum treatment. Tertiary treatment at Nashua.
*****Secondary treatment as minimum treatment. Tertiary treatment at Nashua and Lawrence.

P = Primary Treatment S = Secondary Treatment T = Tertiary Treatment

TABLE 2. STREAM QUALITY CLASSIFICATION COMPUTED FOR 1976 BOD LOADS

Reach	River Mile		Quality Desired	Classification Computed								
	From	To		I	II	III	IV	V	VI	VII*	VIII**	IX***
1	0.0	11.80	SB	N	N	N	B	B	B	B	B	B
2	11.80	21.90	SC	N	N	N	D	C	C	C	B	B
3	21.90	29.10	C	N	N	N	D	C	C	C	B	B
4	29.10	33.10	B	N	N	D	D	C	C	C	B	B
5	33.10	40.50	C	D	D	D	D	C	C	C	B	B
6	40.50	47.40	B	N	N	N	D	D	D	D	B	B
7	47.40	54.80	C	D	D	D	D	D	D	D	B	B
8	54.80	67.70	B	D	D	D	D	D	D	C	B	B
9	67.70	73.20	C	B	B	B	B	B	B	B	B	B
10	73.20	115.70	B	B	B	B	B	B	B	B	B	B
11	115.70	160.80	B	B	B	B	B	B	B	B	B	B
12	160.80	172.00	B	B	B	B	B	B	B	B	B	B
Total miles of B Class stream				58.1	58.1	71.3	84.2	84.2	103.1	103.1	171.6	171.6
Total miles of C Class stream				45.8	45.8	32.6	45.0	60.2	41.3	54.2	0	0
Total miles of D Class stream				27.7	27.7	31.7	42.4	27.2	27.2	14.3	0	0
Total miles of nuisance				40.0	40.0	36.0	0	0	0	0	0	0
Total Cost of Construction in millions, with cost of storm water treatment				8.3	13.8	28.6	209.7	279.4	305.4	364.1	372.5	369.4
Total Cost of Construction without storm water treatment				8.3	13.8	28.3	154.0	193.1	202.0	223.9	232.2	229.1

*Completion of States' Implementation Schedule.
**Secondary Treatment Everywhere.
***To meet the Existing Stream Classification.

Miles of stream adjusted by bacterial criteria and print out of simulation model.

TABLE 3. STREAM QUALITY CLASSIFICATION COMPUTED FOR 1995 BOD LOADS

Reach	River Mile From	River Mile To	Quality Desired	Classification Computed I	II	III	IV	V	VI	VII*	VIII**	X***	XI****
1	0.0	11.80	SB	N	N	N	C	C	C	C	B	B	B
2	11.80	21.90	SC	N	N	N	D	C	C	C	C	C	B
3	21.90	29.10	C	N	N	N	D	C	C	C	C	C	B
4	29.10	33.10	B	N	N	N	D	D	D	C	C	B	B
5	33.10	40.50	C	N	N	D	D	C	C	C	B	B	B
6	40.50	47.40	B	N	N	N	D	D	D	D	C	B	B
7	47.40	54.80	C	N	N	N	D	D	D	D	C	B	B
8	54.80	67.70	B	D	D	D	D	D	D	D	B	B	B
9	67.70	73.20	C	B	B	B	B	B	B	B	B	B	B
10	73.20	115.70	B	B	B	B	B	B	B	B	B	B	B
11	115.70	160.80	B	B	B	B	B	B	B	B	B	B	B
12	160.80	172.00	C	B	B	B	B	B	B	B	B	B	B
Total miles of B Class stream				58.1	58.1	71.3	84.2	84.2	103.1	103.1	134.0	152.3	171.6
Total miles of C Class stream				45.8	45.8	32.6	45.0	56.2	37.3	41.3	37.6	19.3	0
Total miles of D Class stream				12.9	12.9	20.3	42.4	31.2	31.2	27.2	0	0	0
Total miles of nuisance				54.8	54.8	47.4	0	0	0	0	0	0	0
Total Cost of Construction in millions, with cost of storm water				8.3	13.8	28.6	209.7	279.4	305.4	364.1	372.5	377.5	385.2
Total Cost of Construction without storm water treatment				8.3	13.8	28.3	154.0	193.1	202.0	223.9	232.2	237.2	245.0

*Completion of States' Implementation Schedule.
**Secondary treatment everywhere.
***Secondary treatment everywhere, plus tertiary treatment at Nashua.
****Secondary treatment everywhere, plus tertiary treatment at Nashua and Lawrence.

Miles of stream adjusted by bacterial criteria and print out of simulation model)

TABLE 4. ALTERNATIVE IMPLEMENTATION SCHEDULES

	Initial Increment		Water Quality Results		
Locations	States' Schedules Increment IV*	This Study's Alternative Schedule	Approved Classification	From States' Schedules	From Alternative Schedule
Newburyport	S	P	SB	C	C
Amesbury	S	-	SB	D	C
Haverhill	S	-	SC	D	C
Lawrence	S	S	C	D	C
Tewksbury	-	-	C	D	C
Lowell	-	S	C	D	C
Dracut	S	-	C	D	C
Chelmsford	S	-	B	D	C
Nashua	S	S	C	D	C
Manchester	-	S	B	D	C
Hooksett	P	-	B	C	C
Concord	-	-	B	C	C
Penacook	S	P	B	B	B
Franklin	S	S	B	B	B
Bristol	S	P	B	B	B
Ashland	S	S	B	B	B
Plymouth	P	P	B	B	B
Lincoln	S	S	C	B	B
Cost, millions of dollars	154	144.8			
Total miles of B class stream				84.2	84.2
Total miles of C class stream				45.0	87.4
Total miles of D class stream				42.4	0

Legend:
S = Secondary Treatment
P = Primary Treatment
B = 75% of Saturation of DO
C = 5 mg/l of DO
D = 2 mg/l of DO
SB = 5 mg/l of DO
SC = 5 mg/l of DO

*Chosen to result in minimum work to achieve no nuisance condition throughout the river.

Miles of stream adjusted by bacterial criteria and print out of simulation program.

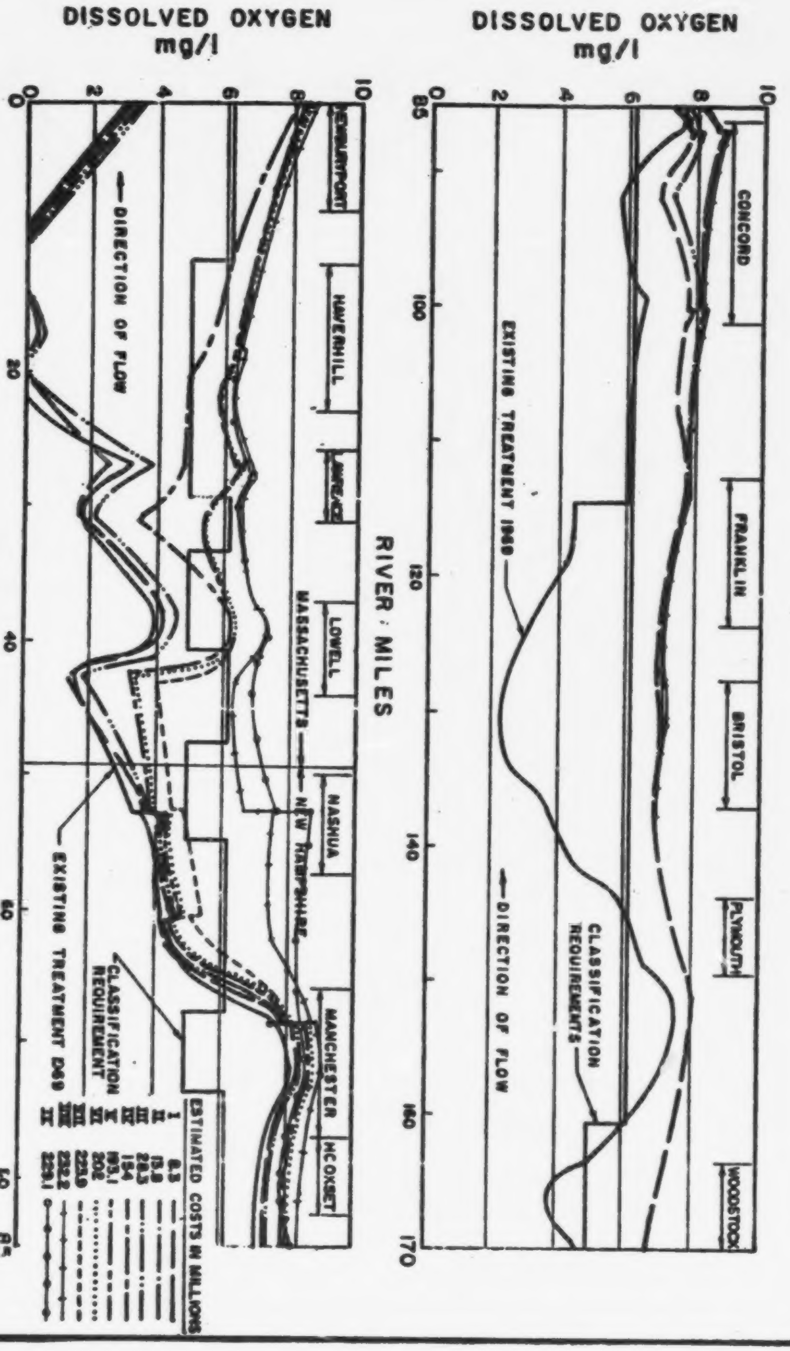


FIG. I -DISSOLVED OXYGEN PROFILES RESULTING FROM EACH INCREMENT OF CONSTRUCTION FOR 1976 BOD LOADS

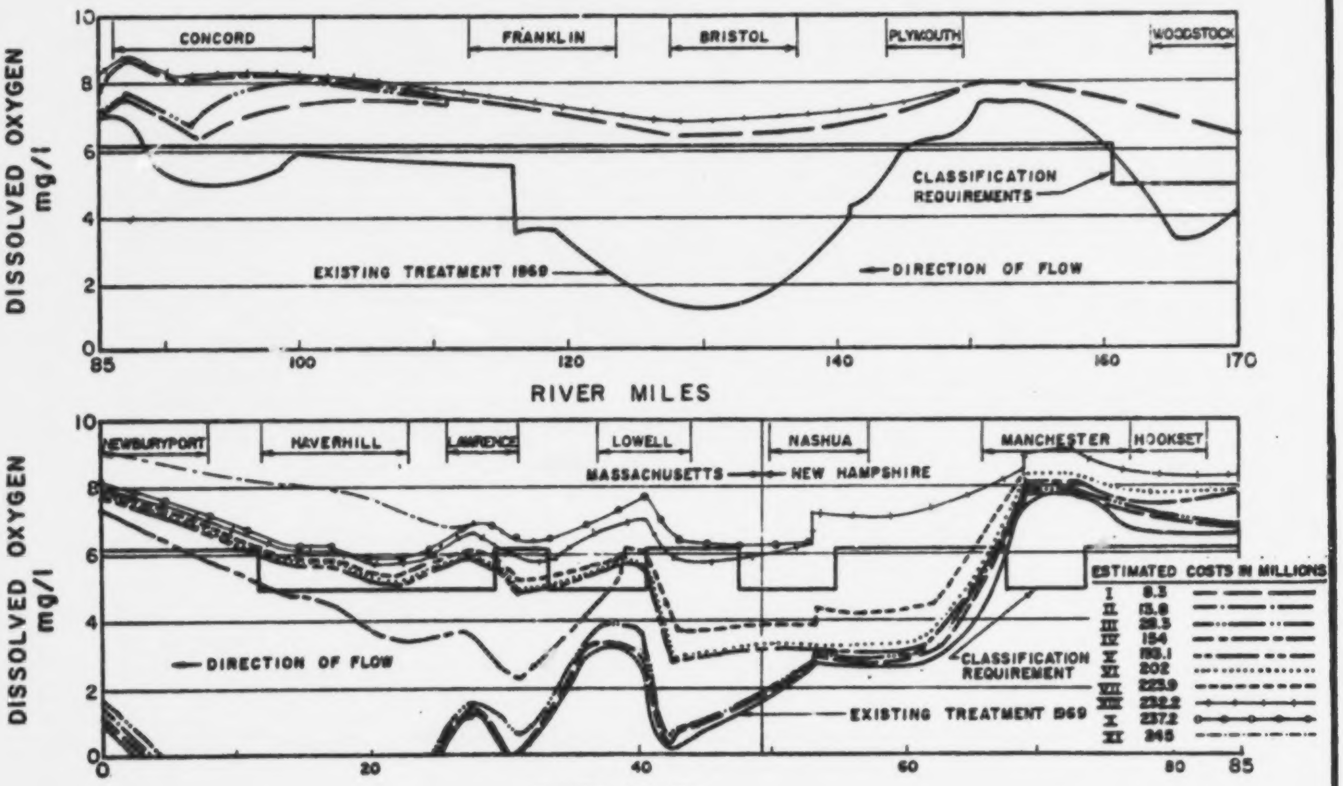


FIG. 2 -DISSOLVED OXYGEN PROFILES RESULTING FROM EACH INCREMENT OF CONSTRUCTION FOR 1995 BOD LOADS

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

OCT 17 1969

Dear Mr. Voss:

This letter transmits the Department of the Interior's review of your draft report to the Congress entitled, "Examination into the Effectiveness of the Construction Grant Program for Abating, Controlling, and Preventing Water Pollution."

The report examines one of the most crucial issues in water pollution control, means of administering Federal financial assistance for the construction of waste treatment facilities in a way which will yield most effective results. This has been a matter of top priority attention within the Department of Interior. However, we have serious reservations concerning some of your conclusions as to how to achieve this goal. We agree with the report's basic premise that more systematic means of awarding construction grants must be found to secure greater benefits in pollution abatement.

Because of the extremely broad nature of the report, and in view of the short time period of response, our comments will cover only the points we consider of major significance.

1. The report points strongly to the need to award construction grants on a more systematic basis. Towards this end you have recommended (p. 99) that "the Secretary of the Interior require that the States, in establishing priorities for the construction of waste treatment facilities, and FWPCA, in approving grant awards for such construction, give consideration to the (1) benefits to be derived from the construction of the facilities, and (2) actions taken, or planned to be taken, by other polluters on the waterway."

We agree with this need and the Department is already moving strongly in that direction. The FWPCA has been working with the States to secure improved priority systems, and a number of States with deficient priority systems have strengthened these to provide for conformance with water quality standards implementation plans and with regional or local water pollution control plans.

Further, the Department is currently completing a comprehensive review of the construction grants issue, of which consideration of State priority systems is a major part. On July 15, 1969, the Secretary sent to the Congress a draft of a proposed bill entitled, "The Water Quality Financial Assistance Act of 1969." In his letter of transmittal, the Secretary pointed to the need to give more careful scrutiny to the priority system followed by the States and his intention to review this matter and to work with the States to accomplish improvements. He stated, "As the review of the criteria progresses, we will want to know what consideration, if any, is being given to the extent to which treatment works contribute to the realization of public benefits, including assurance that other sources of pollution will not preclude the realization of such benefits; provisions for training, surveillance, and adequate project planning and design will assure effective management of the treatment works; the project is part of an effective river basin pollution control plan or management program already developed or under development; the area served takes advantage of economies from large-scale treatment works; and the extent to which the community has established a system of charges or other revenue measures to meet current operation costs of the treatment system, amortization costs, and other requirements."

However, the Department's authority to require improvements in State priority systems is limited under the terms of the Federal Water Pollution Control Act, as amended. The Department's Solicitor's Office has advised as follows:

> "Among the required elements of a State plan are the criteria to be used by the State in determining the priority of sewage treatment projects for purposes of Federal financial assistance. (Section 7(f)(6) 1/ Section 8(b)(5) requires that such State priorities be based on financial and water pollution control needs. If the State's project priorities can reasonably be said to be based on those two criteria, the requirement of Section 7(f)(6) is met. In such case the Secretary is without authority to require other priorities, or to disapprove the State plan because he prefers other priorities."

Authorization for the construction grants program will expire in FY 1971. Legislative proposals for long-range extension of the program will reflect the findings of our current comprehensive review of needs, including needs for more effective distribution of grants to secure pollution control results. In developing our proposals, we will take into consideration your recommendations (p. 100) that "the Congress may wish to consider amending section 8(a) of the Act to provide that priorities for grant awards be established on the basis of benefits to be realized."

2. Although improved priority systems are needed, they in themselves will be of limited value unless those communities contributing the most serious problems can be persuaded or compelled to move forward promptly with construction applications.

The report appears critical of the fact that readiness and willingness of municipalities to proceed has been a major factor in awarding grants, stating (p. 91) "the construction grant program to date has been administered for the most part using a 'shotgun' approach--awarding grants on a first come--first-served or readiness--to-go basis . . . ." However, to be realistic, we must recognize that grants cannot be awarded to communities which are not ready or willing to undertake construction. Failure to give realistic recognition to this very basic problem, which is faced by both State and Federal water pollution control administrators is, we believe, a major weakness in your findings.

Construction of a waste treatment plant, whether under its own finances or through acceptance of a Federal grant, commits a community to a financial obligation for capital and operation and maintenance costs for some years in the future, often to benefit water users downstream. Thus, political and legal pressure is required in many cases to assure construction. The situation is well illustrated by the following quotation from the Maryland State Program Plan:

> " . . . Almost without exception, every sewerage project in Maryland has been undertaken at the suggestion, urging, insistence, formal orders, and, when administrative procedures are exhausted, by court action initiated by the Health Department and the Board of Health and Mental Hygiene.
>
> " . . . Because the application for a grant is made only after the community agrees to proceed with the construction of the project, a hard and fast listing of the priority in which applications will be considered is ill-advised if not unworkable . . . . In Maryland's situation it would be the height of folly to tell some community, after a long and bitter struggle to get them to act, that they would have to wait for financing not because the money wasn't available, but because someone higher on the predetermined priority list had not yet caved in."

Since as a general rule State political leverage on a community may be presumed to be inversely related to cost effectiveness of investment, it is not difficult to see why the small community often builds its plant first. Then, because of inadequate improvement in stream quality, its weight is added to pressures for action by the larger community or industry. However obvious the situation, the way to implementation of the most cost effective investments first has not been so obvious.

We believe, however, that the situation for accomplishing a more systematic approach has considerably improved with increased public awareness and support for pollution control, and with establishment of water quality standards. Water quality standards and other regulations established for interstate and intrastate waters have provided in their implementation plans a basis for a systematic approach to the cleanup of the Nation's waters.

We must now find means of assuring that communities and industries move forward in accordance with those schedules. This involves strengthened State and Federal enforcement action. Towards this end, the Secretary has initiated a more vigorous and aggressive enforcement policy, involving for the first time, direct action against violators of water quality standards.

3. Your report points to the inadequacy of present levels of funding to meet the goals established in the water quality standards. You conclude, therefore (p. 94), "It appears to us that, in view of the magnitude of the water pollution control problem and the limited Federal funds available, it will be many years before the construction grant program is completed. Thus, we believe that interim goals or objectives should be established, whereby significant improvement in water quality and uses can be obtained on some waterways or sections of waterways."

We fully agree that present levels of funding have not been adequate, but cannot agree that interim goals should be established. Our goal is to overcome the vast backlog of unmet waste treatment needs, and to bring the Nation abreast of the pollution problem of its cities over the next five years. For those exceptional cases where installation of high levels of treatment would occasion serious hardship, we are prepared to be realistic and flexible about the timing for necessary waste treatment improvements. However, for the vast majority of cases interim goals or phased development of treatment stages would only make more expensive and difficult a solution which should be dealt with by applying the necessary treatment technology now.

The Department is seeking additional means of financially assisting communities to meet those goals. Towards this end the Secretary has already sought new legislation which would provide alternate means of Federal financing and has transmitted the proposed "Water Quality Financial Assistance Act of 1969" to the Congress. The States are greatly accelerating their participation in the funding of municipal waste treatment facilities. Further, the Department has greatly strengthened its enforcement activities which, although not described in your report, are an important means of securing more rapid progress.

Our approach, therefore, is a twofold one--that of seeking additional means of financial assistance and of strengthening our enforcement activities--rather than deferring our national goals in this essential effort.

4. In connection with establishment of interim goals, you state (p. 86), "We believe that the secondary treatment policy may be a desirable long-range objective. However, as stated previously it is our opinion that because of the magnitude of the construction program and the limited funds available, interim objectives or goals should be established. Such interim goals could include the attainment of the State's water quality standards. In this regard, we believe that the assimilative capacity of waterways should be considered in planning for the construction of waste treatment plants. In some cases, secondary treatment at all locations will be insufficient to maintain the desired quality of a waterway, while in other cases only primary treatment may be necessary."

We do not concur that less than secondary treatment would represent an adequate national policy at this time, except in the case of some coastal waters. Even before the establishment of water quality standards, secondary treatment had increasingly become an accepted general requirement, with an equivalent degree of treatment for industrial wastes. In the face of population and industrial growth, treatment requirements have had to be steadily upgraded; waste loads have grown enormously with the growth of population and industries. History has shown that deterioration of many waters has been the inevitable accompaniment of economic growth because past treatment goals were set too low. After many years of inadequate waste treatment, serious water quality degradation is a fact in most developed parts of the country.

The day has long since passed when we could rely on assimilative capacity to protect us from water quality degradation and curtailment of water uses associated with clean waters. The traditional assimilative capacity concepts have ignored the more subtle water pollution control parameters so important to the protection of legitimate water uses such as biostimulation, toxicity and taste and odor producing substances. Secondary treatment moves a large number of deleterious substances which are not substantially reduced by primary treatment. Degration of stream quality occurs from discharging primary effluent, even in streams where the dilution or conventional assimilative capacity is large.

If we are to make effective progress, a substantial reduction of pollution from all municipal and industrial waste sources will be necessary. Secondary treatment, and treatment levels beyond that, should be considered a necessary goal to allow us to get ahead of the pollution problem--to prevent pollution rather than to wait to abate it after damage has occurred. The keystone of the Water Quality Act of 1965 was enhancement of water quality and this has become the keystone of the State-Federal water quality standards. We cannot afford to aim for less.

5. You recommend (p. 99), "that FWPCA utilize systems analysis techniques in the planning for and implementing of water pollution control programs."

We fully agree that the systems approach should be applied where it can make a significant contribution to pollution abatement. Many pollution problems are, of course, not complex and sophisticated analytical procedures would make little contribution to their solution.

Mathematical programming and simulation models provide enormous analytical capability. Basic analytical tools for modeling the water quality situation and control costs have been demonstrated, not only in the Merrimack through the model developed for the General Accounting Office by Camp, Dresser, and McKee (CDM), but also in many other areas by FWPCA and others. As suggested by your report, some States, Texas and Maryland to name two, are taking advantage of such techniques developed by FWPCA to study complex problems.

We believe that FWPCA has already developed a modeling capability much more advanced than is implied in the discussion in the report (pp. 73-74), and has indeed developed models similar to those developed by CDM. The early Dallas (1960) and Delaware Estuary (1963) models encompassed the same basic logic as the CDM simulation model, and the Delaware utilized a cost model not unlike the mixed integer programming techniques applied by CDM. Since that time more advanced techniques designed to overcome the deficiencies of earlier techniques have been developed and applied.

We should point out, however, that testing of our systems approaches, in the Delaware Estuary and through our research project on the Brandywine, for example, has demonstrated that governmental entities simply have not, or could not, restructure themselves to implement the types of solutions which these analyses have yielded, and which are suggested by the CDM report. Toward better understanding of this, research and development resources must be directed into such areas as governmental decision-making processes, means of dealing with objectives other than economic efficiency in our analytical techniques, and feasible coalitions of governmental units. Until such time as these questions are at least partially answered, there will be extreme difficulty in bringing to bear the full power to the systems approach on actual pollution control actions.

Thus, the more direct approach reflected in the water quality standards implementation plans and enforcement conference remedial schedules is generally called for at this time. However, we are looking to the future, when systems analysis will play a greater role in developing practical basinwide solutions. Towards this end, we are continuing our work on development and utilization of models, strengthening our staff capability, and building the necessary data base for such work.

6. Because your report draws heavily upon the model developed by CDM, and applied to the Merrimack Basin we are providing our specific evaluation of that model.

We do not believe the study provides a pragmatic and effective guide to necessary pollution abatement actions in the Merrimack River. This conclusion does not reflect lack of competence on the part of Camp, Dresser, and McKee; on the contrary they have performed a creditable modeling study within a very short time period and within the limits of available data. Our conclusion stems largely from some fundamental limitations in the method, limitations which CDM and the General Accounting Office, to a large extent, have also identified.

These limitations are such that an attempt to directly apply the results of the CDM study at this time would, we feel, cause significant problems at State and local levels, resulting in an unnecessary delay in achieving pollution control goals and yielding an uncertain result in terms of water quality.

The limitations are of three types: technical, policy objectives, and feasibility of implementation.

(a) The technical limitations are as follows:

(1) The model provides no information on risk of system failure under real world discharge conditions. Additional treatment capability costs may often be justified on the basis of avoiding risk. The need to explicitly examine risk of system failure and its magnitude and

persistence is one reason why FWPCA has moved away from this type of model toward stochastic simulation. An analysis of the better and worse conditions which pertain in a variable system can allow for more flexibility in deciding which course of action to follow.

(2) In the absence of model verification against observed conditions, and lack of sensitivity studies there is no way to evaluate the degree to which the real system is represented or the extent to which misestimation of the parameters will affect the solutions. Our experience has shown the need for such analyses before one can put much faith in the answers. Perhaps the most important variables used in the CDM study are stream loadings, which are assumed constant; deoxygenation coefficients which are not well defined and do not appear to be comparable between the CDM and FWPCA studies conducted about two years apart; and stream flows, which are also assumed constant. The estimates of oxygen demand of existing bottom deposits are questionable.

In addition, the model utilizes measured in-stream reaction rates determined under conditions of extreme pollution. Recent evidence indicated that major changes in waste removal will modify these rates such that more treatment will actually be required than would be predicted by the model. This factor was not taken into account; therefore it is likely that the levels of treatment indicated as least costly will not in fact produce the desired results in stream quality.

(3) The model considers dissolved oxygen as the sole criterion for optimization. This is not an adequate general reflection of the true state of nature. Other quality variables, such as dissolved solids, color, pH, nutrients, and temperature and their synergistic effects, need to be considered as well. Algae are provided for in the model as sources or sinks of oxygen, but this was not considered in the model's application to the Merrimack. Further, algae are themselves considered detrimental to certain in-stream uses and to esthetic enjoyment, and must

also be considered from that point of view. It is noted, too, that adequate models of the nutrient-trace minerals-photosynthetic-sediment algae relationships do not currently exist and are not likely to be developed for several years. This, then is a problem which must be handled with cruder decision tools.

(4) The model assumes the efficacy of chlorination as a disinfectant on primary wastes. Coliform bacteria are reduced by primary treatment and disinfection. However, secondary treatment achieves a more effective reduction of bacteria. Further, viruses are apparently relatively unaffected by primary treatment and disinfection, but are reduced by secondary treatment. Hence, public health considerations indicate secondary treatment for recreational and shellfish areas.

(5) The report deals generally with the problem of combined sewer overflows, but neglects to mention or analyze the fact that secondary or tertiary treatment, by removing additional waste loads from the stream, may permit the river to handle the combined sewer overflows with less damaging impact until such time as they can be brought under control.

(b) The report is premised on policy objectives more limited than those pursued by FWPCA in response to the mandates in the Federal Water Pollution Control Act. The CDM analysis is based upon a greater degree of risks of not meeting standards than we are willing to accept. The CDM approach implicitly assumes that underbuilding and later upgrading is preferable to the FWPCA approach, which is aimed at minimizing the risk associated with not meeting standards. Under the FWPCA approach the provision of additional secondary treatment will serve to enhance the quality above the standards and serve as a buffer against risk and future growth.

(c) Perhaps most important, the study has not come to grips with nor demonstrated the significant final stage of the systems approach--implementation. The technical capability to model at least partially, the type of problem dealt with in the CDM model has existed for some time; the difficulty lies in implementation of the solution within the context of present as well as future political organizations. One of the chief impediments to controlling pollutants is the question of jurisdictional prerogatives and responsibilities. There is limited value to a technical solution which violates basic public values in terms of political organization; or practical values as to who pays and how much, relative to his neighbor; or who controls the jobs in the waste treatment plant and who establishes the charges levied to pay for the works.

7. Your report selects the Merrimack as an example of how systems analysis techniques can be utilized in planning and implementing water pollution control programs. We have discussed the limitations of this approach; we will nowdescribe the current FWPCA approach to pollution abatement for this river.

The construction program being developed in the water quality standards and through the Federal enforcement conference should be completed as soon as possible. State priorities for construction grants should be consistent with this objective. No additional basin planning studies are needed at this time to provide a solution to this immediate problem. A number of previous planning studies of the Merrimack have all recommended essentially the same configurations of waste treatment systems.

As these municipal and industrial waste treatment systems are constructed, the second phase of the program will require additional planning studies.

These studies should include evaluations of the desirability of raising standards on specific reaches in accordance with emerging uses such as open space and recreation, of additional treatment needs, of effects of storm water overflow, of nutrient enrichment, of development of arrangements for stormflow regulation, and of other aspects of water quality management.

Systems analysis will play an important role in these planning studies. Essential to this second phase of planning and water quality management, however, is a willingness on the part of the communities and industries concerned to take collective action in implementing the findings. Therefore, our efforts will also be directed towards working with the States to secure the necessary institutional improvements for accomplishing this.

We believe that this two-phased approach, that of taking urgently needed abatement actions now and beginning to develop a more sophisticated water quality management approach for the future, is a sound and essential course of action.

8. You recommend (p. 99) that, "in applying systems analysis techniques, the Secretary consider the practicability of FWPCA providing the necessary computer equipment through its STORET system, and the States utilizing such equipment in (1) determining their water pollution control requirements, (2) identifying alternatives available to solve water pollution problems, (3) formulating water pollution control plans, and (4) establishing implementation schedules and priorities for the construction of waste treatment facilities."

We fully concur with the need to make the STORET system available for utilization by the States. Towards this end, FWPCA has been meeting with State, interstate and other Federal agencies through seminars, short meetings, or training courses. These meetings explain STORET and how it can be used by any water pollution control activity, to provide data on water quality, municipal waste inventories, contract awards, and municipal and industrial implementation schedules.

As a result of such meetings 17 State and 2 interstate agencies, 7 Federal agencies, and 5 local groups are using STORET to store and retrieve data.

FWPCA is expanding both its data collection activities and provision of STORET services as rapidly as resources permit. Our objective is to fully develop an information system which provides for adequate basic data and its complete interchange between State and Federal levels.

9. You discuss (pp. 82-84) the, "importance of considering a river basin in its entirety without regard to the political boundaries of States or municipalities." You suggest that a solution may be the establishment of river basin authorities or interstate compact commissions to accomplish more effective pollution control.

We completely agree with the need to consider water pollution control on a river basin or regional basis. As a first step, we are attempting to approach this realistically within the existing institutional framework. To this end, we are utilizing water quality standards, enforcement programs for entire river basins.

Second, we recognize the need to improve the existing institutional framework, and are working towards that end to the extent practicable. A large part of the need for improved regional approaches lies at the metropolitan area level. Although the regional metropolitan waste handling system is an accepted approach in many American cities there are far too many cases where fragmented local systems persist. The FWPCA is working to find additional means of encouraging and supporting the development of such systems through administration of its construction grants program.

In addition, under Section 3(c) of the Federal Act, we are making basin planning grants to encourage development of basin-wide institutional arrangements. Further, we are supporting and encouraging existing compact commissions such as the Delaware River Basin Commission and the Ohio River Valley Water Sanitation Commission, to increase their effective participation in basin wide abatement programs.

Meanwhile, we are moving forward as rapidly and vigorously as possible to abate pollution within the existing institutional framework.

We appreciate the opportunity to review your report.

Sincerely yours,

J. J. Wall Jr.

Director of Survey and Review

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY
WASHINGTON, D.C. 20506

September 29, 1969

Dear Mr. Voss:

I am replying to your letter of September 25 for Mr. Berger. Mr. Berger returned to the University of Massachusetts in mid-September and I have taken up his duties in water resources.

I wish to thank you for the opportunity of reviewing the proposed draft of the report to the Congress on the effectiveness of the construction grant program for abating water pollution problems.

In my opinion, it is an excellent report; one which should be very helpful to the Congress and even more helpful to the Federal and state agencies which have been trying to get a handhold on this problem. A great many questions, problems and issues which have confused the picture are put in much better perspective.

Your conclusions and recommendations are sound in my opinion. However, I would like to see a slight modification placed on the recommendation for the increased use of systems analysis to develop sound plans for implementing the Nation's water quality objectives. I would propose that on page 96, paragraph 3 (line 13) you insert after the words ... "under the direction of competent engineers thoroughly experienced in all aspects of water quality management and waste treatment systems, ...".

A similar constraint on the use of systems analysis should be incorporated in the recommendations on page 99.

In defense of this modification, I would refer to the Camp, Dresser and McKee report, appendix page 6 (center of page), page 11 (third paragraph), page 12 (fourth paragraph) and elsewhere throughout that document in which these competent engineers stress the need for experience and judgment in the development of the model as well as in its use. They have produced an effective systems analysis in this case, not so much because of their sophistication in the methodologies commonly known as systems analysis, but because of their excellent understanding of this highly complex system and its attendant problems.

Sincerely,

Warren A. Hall

Dr. Allen R. Voss
Associate Director
U.S. General Accounting Office
Washington, D. C. 20548

CAMP, DRESSER & McKEE

CONSULTING ENGINEERS

WATER RESOURCES
WATER SUPPLY AND TREATMENT
SEWERAGE AND SEWAGE TREATMENT
INDUSTRIAL WASTE TREATMENT
REPORTS DESIGN
DRAINAGE AND FLOOD CONTROL
WATER AND AIR POLLUTION
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SERVICES DURING CONSTRUCTION

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HERMAN G. DRESSER, EMERITUS

JACK E. McKEE
JOSEPH C. LAWLER
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RICHARD L. WOODWARD

ADMINISTRATIVE MANAGER
ROBERT E. JEWETT

October 3, 1969

United States General Accounting Office
John F. Kennedy Building
Boston, Massachusetts 02108

Gentlemen:

We appreciate having had the opportunity to review the draft copy of your report to the Congress on the "Effectiveness of the Construction Grant Program for Abating, Controlling, and Preventing Water Pollution". The following comment is submitted for your consideration.

We recommend that a stronger statement be made in the conclusions on the lack of Federal assistance for abating pollution from mixed sewage and storm water overflows and treatment. Such a stand is expressed in the main body of the report but is not clear in the conclusions.

We consider the report to be an excellent presentation of the situation as we see it. We feel that the facts presented are accurate and demonstrate a knowledgeable view of the problems.

Very truly yours,

CAMP, DRESSER & McKEE

Robert H Culver

Robert H. Culver

RHC:mb

ONE CENTER PLAZA BOSTON, MASS. 02108 TEL. 617 742-5151 CABLE: CAMDRES

CDM

Arkansas **POLLUTION CONTROL COMMISSION**
DEDICATED TO CLEAN AIR AND WATER

1100 HARRINGTON / LITTLE ROCK, ARKANSAS 72202
TELEPHONE 371-1701

LADD DAVIES, Director

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October 1, 1969

Mr. Allen R. Voss
Associate Director
United States General Accounting Office
441 G Street, N.W.
Washington, D. C. 20548

Dear Mr. Voss:

We have reviewed the report entitled "Examination into the Effectiveness of The Construction Grant Program for Abating, Controlling, and Preventing Water Pollution" and find that, for the most part, it represents a factual statement of the methods employed by our Commission in alloting PL660 construction grants. However, we feel that the report does not give a complete picture of the reasons behind the "shotgun" approach employed by ourselves and the other States.

We in Arkansas have been fortunate enough to have a large quantity of good water coupled with a relatively small number of polluters, most of these pollutors being of relatively small significance when judged as to the amount of actual water pollution caused by their operations. With this fact in mind, we have endeavored down through the years to abate and control pollution from existing facilities whenever and wherever possible, with the ultimate objective being the abatement of all existing sources. Needless to say, we have required strict compliance from all new potential pollution sources such as municipalities with new sewerage systems.

In Arkansas, one of the major problems facing the Cities and Towns is that of financing public works projects due to economic and legislative restrictions. In view of this problem, we utilized the "shotgun" approach to the end that since 1957 we have provided adequate treatment for approximately 115 previously untreated or inadequately treated municipal sources of pollution and have provided adequate treatment for over 70 new potential municipal sources as referenced above. Until FY 1968, we utilized the first come-first served approach as funds exceeded requests. However, we maintained our priority system, which has existed since 1957, in the event that this situation reversed itself, which it did in FY 1968. While we will use the priority system should several cities with varying priorities be ready to proceed simultaneously in the face of a shortage of funds, we see no reason for not allocating a PL660 grant to a community that has a low priority but is ready to proceed while a higher priority community has not completed, or even started, its financing procedures. It appears obvious to us that the use of a system whereby all projects have to wait on the one having the highest priority to proceed first would not only waste time but would increase the cost of facilities for those who had to wait.

In addition, we have always taken the position of allocating grants on the following basis (1) First to those projects which are ready to proceed with treatment of a previously untreated or inadequately source and (2) Those communities which do not have an existing source of pollution (unsewered communities). In summary, we feel that our approach to the problem is the most logical one in the face of the difficulties previously mentioned. We further feel that to do it any other way would only result in a waste of valuable time and unnecessary expenditure of funds, both local and Federal.

Another statement in this report that we would like to comment on is that which states on pages 94-95 that, "In this regard, the FWPCA requirement of secondary treatment may be desirable as the ultimate objective. We believe, however, that as an interim measure consideration should be given to less than secondary treatment when such treatment will result in enhancing the water quality or attaining the States water quality standards." Until the establishment of water quality standards in 1967, it was our policy to require a minimum of primary treatment before discharge to the Arkansas or Mississippi Rivers, and secondary treatment for all other discharges, regardless of whether they were into interstate or intrastate streams. When the water quality standards were written, a minimum of secondary treatment, at the prompting of the FWPCA, was established for all municipalities, located on the Arkansas and Mississippi Rivers. In view of our prior requirements, plus those added by the water quality standards, we feel that it would be extremely unfair, as well as costly, to permit for example, the City of North Little Rock (population 61,510) to construct only primary treatment facilities, while requiring the Cities of Little Rock (population 128,929) and Pine Bluff (population 57,899) to construct and operate secondary treatment facilities, simply because of the fact that the Arkansas River could only assimilate an organic load from a PE of 42,000 persons. In short, we feel that a minimum method of treatment, secondary in our case, should be adopted and applied to all discharges, because, in addition to being fair, the discrimination between treatment for one city and another would give the city employing primary treatment a substantial financial advantage due to construction, operating, and maintenance costs.

In summary, we feel that, while the report presented a factual account of our operation of the PL660 grant program, more attention should have been given to the reasons and circumstances which precipitated this method of operation. While we are sure that some areas of the program need revision or modification, it is felt that great progress has been and will continue to be made in realizing a final solution to the water pollution problem in Arkansas and in other States.

It was obviously the intent of Congress that the States should make the decisions as to where the money will be best spent. May it always remain so.

Yours very truly,

S. Ladd Davies

S. Ladd Davies
Director

SLD:mr

STATE OF MAINE
WATER AND AIR ENVIRONMENTAL
IMPROVEMENT COMMISSION
AUGUSTA, MAINE 04330

October 10, 1969

Mr. Allen R. Voss
Associate Director
United States General
Accounting Office
Washington, D. C. 20548

Dear Mr. Voss:

Reference is made to your communication of September 25, 1969 and the draft of the General Accounting Office's report to the Congress.

We wish to call attention to the following items contained in the report.

a. On page 49, example 6, the situation is not adequately described. The two cities and industry involved were issued abatement orders. This occurred following the application for federal grant-in-aid by one community when it seemed the others involved were about to falter. The second community had planned a project to at least partially include the industry and for some reason voters of the community did not accept. Then began the road back to the present time with the second city daily expecting authorization to advertise for bids. I do not think the first community suffered financially or in any other way as a result.

b. In the case of the stream, example 8, page 53, it is pointed out that enforcement of the classification of the stream was carried out by the water pollution control agency. The agency also held a public hearing and granted a license to the industry in question to discharge the waste altered by the treatment prescribed in the license, could have been assimilated by the stream but when the license was violated and a complaint was made to law enforcement agencies no action was taken. Also the downgrading was done by the State Legislature over the expressed opposition of the Commission (charged with administering of statute). The write up of the draft seemed to indicate the pollution control agency was responsible for downgrading the stream.

October 10, 1969

Mr. Allen R. Voss
Washington, D.C.

d. The total river basin approach is advocated in this draft. I take issue with this as a inflexible doctrine because within my experience, treatment of one or two waste sources on a stream has resulted in the reclamation of a stream for most of its uses while treatment of three or four more insignificant waste sources did not result in an great change in the usefulness of the waterway.

Very truly yours,

R. W. Macdonald

R.W. Macdonald
Chief Engineer
ENVIRONMENTAL IMPROVEMENT COMMISSION

RWM:lg

The Commonwealth of Massachusetts
Water Resources Commission
State Office Building, Government Center
100 Cambridge Street, Boston 02202

OFFICE OF THE DIRECTOR
DIVISION OF WATER
POLLUTION CONTROL

October 10, 1969

Mr. Allen R. Voss
Associate Director
U. S. General Accounting Office
441 G. Street
Washington, D. C. 20548

Dear Mr. Voss:

Reference is made to your letter of September 25, 1969 requesting our review and comments on your draft on a report to the Congress of the United States titled: "Examination into the effectiveness of the construction grant program for abating, controlling and preventing water pollution".

In order to meet our water quality objectives and the mandate of both the Legislature and the people, a minimum of secondary treatment with chlorination of all our inland waters is necessary. The philosophy expressed in the report of providing less than this degree of treatment is contrary to the mandate of the General Court and the expressed desires of the citizens of the Commonwealth and thus this philosophy is politically, socially, institutionally, and practically unacceptable at this time.

Much of your report relates to the practices of the state prior to 1967 - which is prior to both the enactment of the Massachusetts construction grants legislation providing assistance to the municipalities, and the development of a pollution abatement program by this Division. It should be realized that this State could not compel communities to construct treatment facilities if they did not have the financial ability to do so. A study of the effects on the tax rate without such aid shows that the burden would be too great in almost all instances. It is admitted that the amount of Federal aid prior to 1967 was so small that no meaningful program could be developed.

Since the recent passage of Federal and State laws, new water pollution control programs are being implemented and, while some of the programs have not been institutionally perfected, they should not be scrapped or a moratorium placed on all construction until further studies and plans are made.

We believe that your suggestion that the construction be carried out on a cost-benefit basis is a good approach but, unfortunately, it would take years to make such determinations, while pollution is increasing at an accelerated pace. We agree that political and institutional constraints have affected our program in the past and ways should be found to overcome these constraints. It should be noted that in our opinion radical changes in the water pollution control field cannot be effectuated in the foreseeable future because of strong home rule and social reluctance to change.

It is noted that no reference is made to the threats of Federal enforcement action in instances of slippage in the State implementation program even though such slippage can, in general, be related to the failure of Congress to appropriate the authorized funds. It is our opinion that a much better climate would exist for considering better and newer approaches should the Congress amend the Federal Water Pollution Control Act to make it clear that Federal funds and Federal enforcement are directly related.

In regard to the Camp, Dresser and McKee report on the development of a mathematical model for minimizing construction costs in water pollution control, we believe it is an excellent report insofar as the dissolved oxygen parameter is concerned. However, as previously stated, the objectives of the Massachusetts program are to make it mandatory for us to use other parameters. In order for us to meet our objectives, secondary treatment along the entire length of the river is required.

Very truly yours,

Thomas C. McMahon

Thomas C. McMahon
Director

TCM:JBC:air
cc: L. Klashman, FWPCA, J. F. Kennedy Building, Boston, Mass.
Camp, Dresser & McKee, 1 Center Plaza, Boston, Mass.

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TEXAS WATER QUALITY BOARD

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BEN RAMSEY
J. R. SINGLETON
HUGH C. YANTIS, JR
EXECUTIVE DIRECTOR

1108 LAVACA ST 475-2651
AUSTIN, TEXAS 78701

October 16, 1969

Mr. Allen R. Voss
Associate Director
United States General
Accounting Office
Civil Division
Washington, D.C. 20548

Dear Mr. Voss:

The report which your office made on the effectiveness of the Construction Grants Program has been reviewed by the staff of this agency.

In our review, we found a few points within the body of the report on which we have commented. These comments are in the attached report prepared by my staff. The report as a whole appears to be satisfactory and the general conclusions offered on Pages 121 and 122 are realistic. We are in general, although not absolute, agreement with these conclusions and would not take exceptions with your findings.

Perhaps the general comment that I would offer that is not included in the review by my staff is that water quality management or water pollution control is, above all, a common sense and a judgment matter that cannot be subordinated entirely to system analysis techniques or other rigid procedural mechanisms. Further, regardless of the fact that river basin boundaries almost never coincide with political boundaries, and within a river basin there may be a multitude of local jurisdictions, water pollution control needs cannot be the sole criterion for changing the shape of, or processes of, local governments. However, beneficial efficient administration of a water pollution control program may be, the people of a river

Mr. Allen R. Voss
Page 2
October 16, 1969

basin, and especially those local government within the river basin, have a right to accomplish reasonable goals by awkward or less than efficient mechanisms if they choose to do so. Perhaps these comments can be summed up by simply stating that we are people dealing with people, and not rulers dealing with subjects.

I trust you will find these comments beneficial. Again, let me express my appreciation for the opportunity of reviewing and commenting on this report.

Very truly yours,

Hugh C. Yantis Jr.

Hugh C. Yantis, Jr.
Executive Director

ccs: Mr. William C. Galegar
Chairman - Texas Water Quality Board

United States General Accounting Office
Dallas Regional Office
Room 600, Rio Grande National Building
251 N. Field Street
Dallas, Texas 75202

APPENDIX IX

STATES THAT HAVE MATCHING GRANT PROGRAMS FOR CONSTRUCTION OF WASTE TREATMENT FACILITIES UNDER PUBLIC LAW 84-660, AS AMENDED (as of February 1, 1969)

Region and State	Percentage of matching grants
NORTHEAST:	
Connecticut	30
Delaware	40[a]
Maine	30
Massachusetts	30
New Hampshire	40
New Jersey	10[b]
New York	30
Rhode Island	25
Vermont	30
MIDDLE ATLANTIC:	
Maryland	30
Pennsylvania	30
District of Columbia	25
SOUTHEAST:	
Georgia	(c)
Tennessee	(c)
Puerto Rico	25
Virgin Islands	25
OHIO BASIN:	
Indiana	30
GREAT LAKES:	
Michigan	30
Wisconsin	30
MISSOURI BASIN:	
Missouri	30
Nebraska	(c)
SOUTH CENTRAL:	
Texas	(c)
SOUTHWEST:	
California	-
Guam	25
NORTHWEST:	
Oregon	25
Washington	15

[a] Up to a maximum of $100,000.

[b] 30% authorized but only 10% funded. Legislation pending for increased funding.

[c] Matching grants authorized but not funded.

GRANTS FOR CONSTRUCTION OF WASTE TREATMENT FACILITIES
UNDER SECTION 8 OF THE FEDERAL WATER POLLUTION CONTROL ACT
ALLOCATIONS TO STATES AND GRANTS AWARDED DURING FISCAL YEARS 1957-69

State	Initial allocations	Awards (note a)
Alabama	$ 27,277,700	$ 27,289,100
Alaska	8,228,100	4,736,600
Arizona	14,738,600	14,312,100
Arkansas	21,696,300	21,361,500
California	74,345,400	74,547,500
Colorado	15,893,100	15,292,500
Connecticut	17,481,900	15,769,000
Delaware	8,152,100	7,660,500
Florida	30,131,900	29,647,200
Georgia	28,832,100	28,691,600
Hawaii	11,033,900	10,638,800
Idaho	13,066,300	6,935,500
Illinois	51,804,800	52,649,600
Indiana	28,941,100	29,335,700
Iowa	21,457,500	21,476,600
Kansas	18,553,500	17,428,900
Kentucky	25,428,100	24,380,800
Louisiana	25,604,800	24,151,800
Maine	14,338,900	11,795,500
Maryland	21,076,600	18,276,900
Massachusetts	30,418,900	28,933,500
Michigan	42,281,000	40,086,100
Minnesota	24,061,700	24,232,300
Mississippi	25,370,500	20,059,700
Missouri	27,817,900	28,328,800
Montana	11,988,300	5,761,600
Nebraska	15,289,600	13,574,300
Nevada	7,656,500	6,939,800
New Hampshire	11,600,500	10,759,700
New Jersey	33,529,600	34,264,800
New Mexico	14,336,000	11,579,700
New York	81,736,200	81,184,800
North Carolina	32,072,000	31,388,000
North Dakota	13,551,000	5,208,300
Ohio	50,706,800	49,552,700
Oklahoma	20,824,300	20,067,800
Oregon	16,123,200	16,424,900
Pennsylvania	59,136,200	52,748,400
Rhode Island	12,063,000	9,184,100
South Carolina	23,785,400	22,725,300
South Dakota	13,796,000	5,482,700
Tennessee	27,755,400	26,769,400
Texas	51,721,300	50,475,500
Utah	13,498,900	9,455,700
Vermont	11,627,900	10,307,700
Virginia	27,356,900	25,899,200
Washington	20,473,700	20,708,300
West Virginia	19,689,700	16,882,500
Wisconsin	26,109,800	26,697,200
Wyoming	9,806,600	2,251,200
District of Columbia	9,733,500	9,879,000
Guam	11,593,700	803,000
Puerto Rico	26,039,600	14,618,300
Virgin Islands	15,566,900	1,776,000
	$1,317,000,000	$1,191,388,000

[a] Construction grant funds not obligated within 6 months after the end of the fiscal year for which appropriated are subject to reallocation. Some States' obligations, therefore, exceed their initial allocations.

APPENDIX XI

STATUS OF WATER QUALITY STANDARDS

AS OF JUNE 30, 1969

Approved without exceptions		Approved with exceptions	
State	Date	State	Date
Arizona	Sept. 1968	Alabama	Feb. 1968
Arkansas	Aug. 1967	Alaska	Do.
Florida	Jan. 1969	California	Jan. 1969
Georgia	July 1967	Colorado	Oct. 1968
Hawaii	Mar. 1968	Connecticut	Feb. 1968
Idaho	Feb. 1968[a]	Delaware	Mar. 1968
Indiana	July 1967	Illinois	Jan. 1968
Maryland	Aug. 1967	Iowa	Jan. 1969
Massachusetts	Aug. 1967	Kansas	Apr. 1969
Montana	Feb. 1968	Kentucky	Mar. 1969
Nebraska	Dec. 1968	Louisiana	Feb. 1968
Nevada	June 1968	Maine	June 1968
New York	Aug. 1967[b]	Michigan	Apr. 1968
Oregon	Sept. 1968	Minnesota	June 1968
Pennsylvania	May 1968	Mississippi	May 1968
South Dakota	Aug. 1967	Missouri	Feb. 1968
Texas	Jan. 1968	New Hampshire	Aug. 1968
Utah	Dec. 1968	New Jersey	Mar. 1968
Washington	Jan. 1968	New Mexico	July 1968
Wisconsin	Jan. 1968	North Carolina	May 1968
Wyoming	Nov. 1968	North Dakota	Aug. 1967
District of Columbia	Jan. 1969[c]	Ohio	Mar. 1968
Guam	June 1968	Oklahoma	Feb. 1968
Puerto Rico	Dec. 1968	Rhode Island	Jan. 1968
Virgin Islands	Feb. 1968	South Carolina	Oct. 1968
		Tennessee	Feb. 1968
		Vermont	June 1968
		Virginia	Jan. 1969
		West Virginia	May 1968

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[a] Approved with exceptions--Aug. 1967.

[b] Approved with exceptions--July 1967.

[c] Approved with exceptions--April 1968.

PRINCIPAL OFFICIALS
OF THE DEPARTMENT OF THE INTERIOR
RESPONSIBLE FOR ADMINISTRATION OF THE ACTIVITIES
DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
SECRETARY OF THE INTERIOR:		
Walter J. Hickel	Feb. 1969	Present
Stewart L. Udall	Jan. 1961	Jan. 1969
ASSISTANT SECRETARY FOR WATER QUALITY AND RESEARCH (note a):		
Carl L. Klein	Mar. 1969	Present
Max N. Edwards	Dec. 1967	Feb. 1969
Frank C. Di Luzio	July 1966	Dec. 1967
COMMISSIONER, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION (note b):		
David D. Dominick	Mar. 1969	Present
Joe G. Moore, Jr.	Feb. 1968	Mar. 1969
James M. Quigley	Mar. 1966	Jan. 1968

[a] Designated as Assistant Secretary for Water Pollution Control until October 1968.

[b] The Federal Water Pollution Control Administration was transferred from the Department of Health, Education, and Welfare in May 1966.